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# **NEW DIRECTIONS IN ENERGY ELECTRICAL ENERGY IN MONTANA**

A DISCUSSION OF OUTLOOK AND ALTERNATIVES

- CONSERVATION, DEMAND, RELIABILITY OF SUPPLY
- ENVIRONMENT, ECONOMICS, COSTS, QUALITY OF LIFE
- WHAT THIS MEANS TO THE CONSUMER

As presented to

**THE MONTANA PUBLIC SERVICE COMMISSION**

By

**THE MONTANA POWER CO.**

JUNE 28, 1978

OCCL 41705446

FEB 3 1982



## NEW DIRECTIONS IN ENERGY

- . Purpose
- . Objectives
- . Overview

## I N D E X

### NEW DIRECTIONS IN ENERGY

|                                                                |          |
|----------------------------------------------------------------|----------|
| Electrical Demand Forecasting and Outlook . . . . .            | Page 4   |
| A View of the Electrical Energy Picture                        |          |
| U.S. and Montana Energy Outlook: The Challenge Ahead . . . . . | Page 43  |
| Conservation, Alternative Energy Potentials                    |          |
| Electrical Energy Supply. . . . .                              | Page 86  |
| Alternatives and Outlook                                       |          |
| A View of Montana's Electrical Energy Picture . . . . .        | Page 123 |
| Supply                                                         |          |
| Costs                                                          |          |
| "What It Takes"                                                |          |
| What It Means to the Consumers                                 |          |

## PROJECTIONS

We should bear clearly in mind the "If ... then" nature of all projections, including those in this discussion ... and their benefits in planning for the future.

As we discussed in an earlier presentation, they are based on a series of facts known today, and reasonable assumptions for the future. "If this happens ... then that is likely to happen".

We expect them to change. Their great value is in building a pathway to the future, which all of us can track, discuss the changes as they occur, and consider their implications for the future.

## ELECTRICAL DEMAND FORECASTING AND OUTLOOK

## NEW DIRECTIONS IN ENERGY

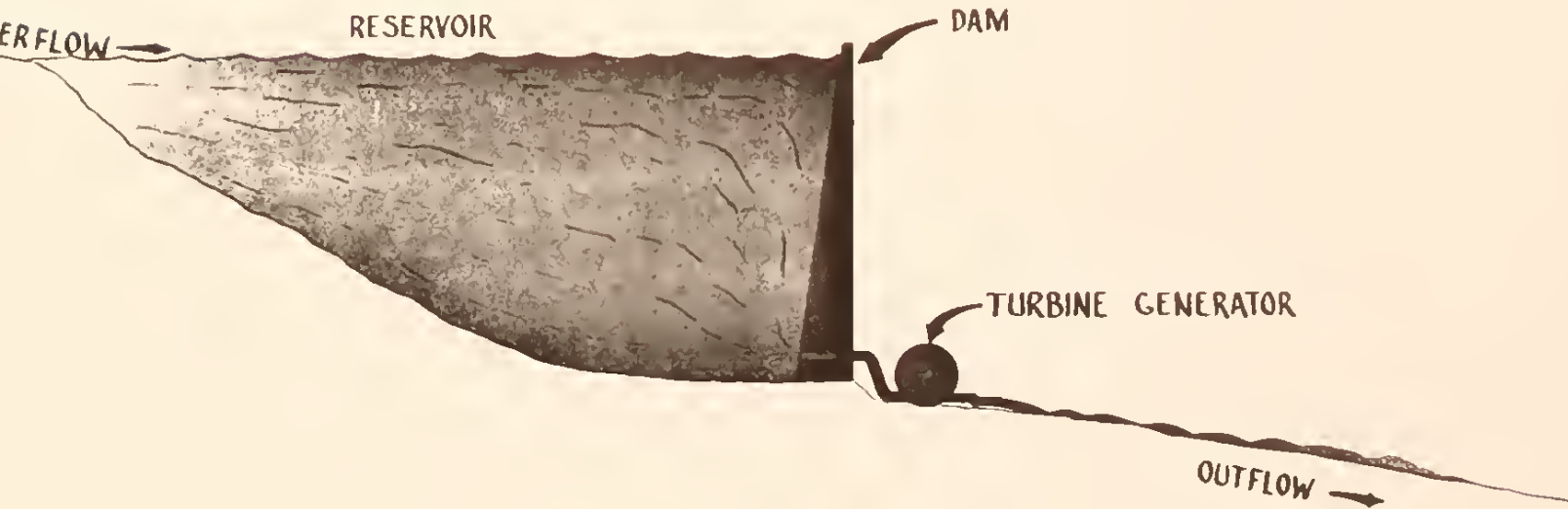
### . Demand Forecasting and Outlook

- . Definition of Terms --- Peak & Energy Load - Peak & Energy Resources
- . Demand Forecasts of '60's and '70's
  - . How they've turned out: Our "Track Record"
- . Changes in world and regional energy use patterns and social and political effects on energy call for new, refined techniques
  - . Econometric Demand Forecasting
  - . Allows a "what if" view of the future
  - . Doesn't make forecasting easier --- more complex
- . Economic/Energy trends and analyses; historical relationships of population; economic activity; energy costs
  - . Conservation Effects      . Load Management      . Other
- . A view of the future:
  - . How it looks now
  - . Tracking, analysis, reporting, "reforecasting"
  - . Potential effects of conservation, alternative energy contribution
  - . On going application of new technologies and new techniques
- . Significance for the future: A basis for viewing, discussing and planning Montana's energy future

## PEAK AND ENERGY DESCRIBED

- . PEAK - RATE OF PRODUCTION OR USE OF ELECTRICITY - KWH PER HR. = KW
  - . We produce at the same rate as the consumer demands.
- . ENERGY - TOTAL QUANTITY OF ELECTRICITY OVER SOME DEFINED PERIOD OF TIME -  
KWH/TIME = AVG. KW
  - . Production and use are the same.
- . HYDRO PROJECT EXAMPLE
  - . To dispel misinformation about increasing hydro energy with additional turbines at existing projects.
  - . PEAK CAPACITY - Determined By Number Of Generators Installed
    - . Can generate as long as the water lasts
  - . ENERGY CAPACITY - Determined By Total Quantity Of Water Available
    - . The water itself represents the energy
    - . Quantity of water is limited at any site
    - . Adding generators does not produce more water
      - . Only allows use of limited water at a faster rate (Peak)

# SIMPLE HYDRO PLANT EXAMPLE



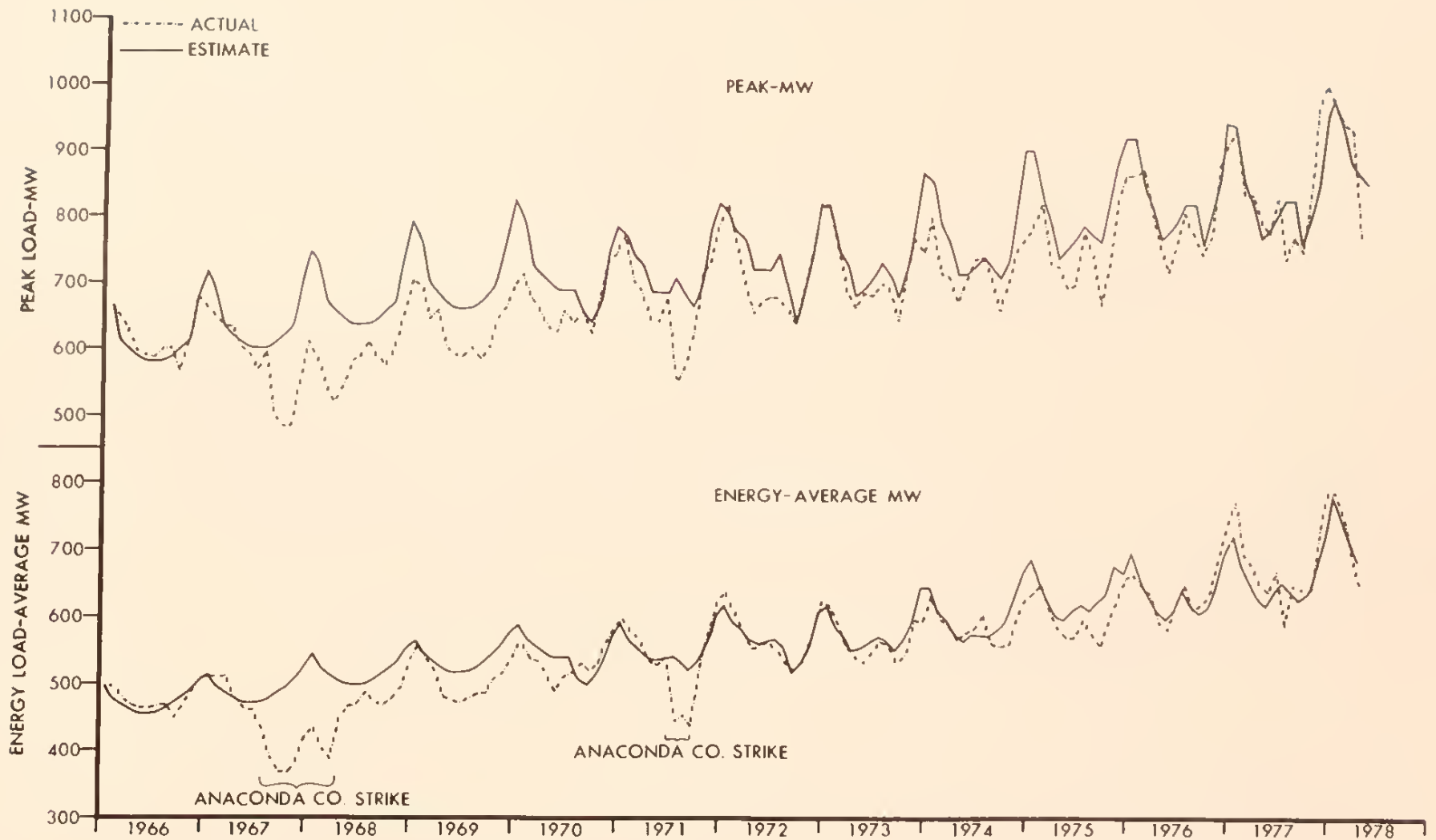
## PAST AND CURRENT ELECTRICAL LOAD FORECASTS

- . Based On Traditional Time-Series Analysis Of Historical Loads
  - . Influenced by judgement
- . TRACK RECORDS
  - . Total Monthly Firm Load - Estimates vs. Actual - Peak & Energy
    - . Fair correlation
  - . Total Monthly Load Less Anaconda Co. - Estimates vs. Actual - Peak & Energy
    - . Good correlation
  - . Annual Energy Loads vs. Forecasts From Inception to Present
    - . 1966 Forecast of 1977 load only 3% high
    - . 1970 Forecast of 1977 load "right on"
    - . 1972 Forecast of 1977 load only 3% high
    - . 1975 Forecast of 1977 load 7% low - faster recovery from recession
    - . 1977 Forecast hopefully better -  
for 1980 only 38 MW difference since 1966

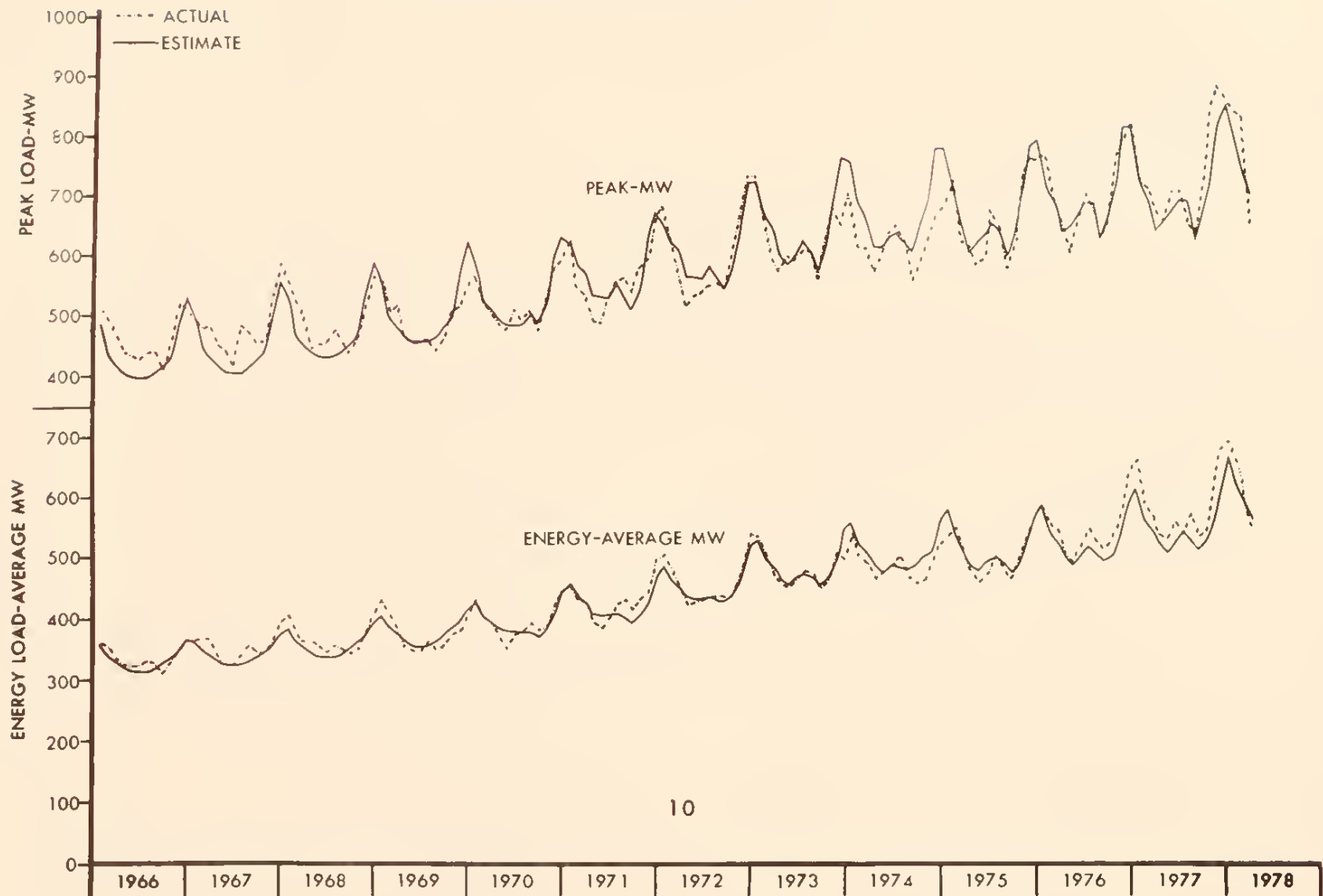
# THE MONTANA POWER COMPANY

## FIRM LOAD COMPARISON

### ACTUAL VS ESTIMATE



THE MONTANA POWER COMPANY  
BASE LOAD COMPARISON  
(TOTAL LOAD LESS ANACONDA CO.)  
ACTUAL VS ESTIMATE



THE MONTANA POWER COMPANY  
TOTAL ENERGY LOAD LESS ANACONDA COMPANY SALES  
FORECASTS VS ACTUAL

|                  | <u>1966</u> | <u>1967</u> | <u>1968</u> | <u>1969</u> | <u>1970</u> | <u>1971</u> | <u>1972</u> | <u>1973</u> | <u>1974</u> | <u>1975</u> | <u>1976</u> | <u>1977</u> | <u>1978</u> | <u>1979</u> | <u>1980</u> | <u>1981</u> | <u>1985</u> |
|------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 1966 Forecast    | 332         | 342         | 358         | 379         | 401         | 425         | 450         | 477         | 505         | 535         | 567         | 600         | 635         | 672         | 712         | 754         | 948         |
| Actual           | 338         | 355         | 372         | 378         | 398         | 429         | 460         | 481         | 491         | 506         | 546         | 581         |             |             |             |             |             |
| % Forecast Error | -1.8        | -3.7        | -3.8        | +0.3        | +0.8        | -0.9        | -2.2        | -0.8        | +2.9        | +5.7        | +3.8        | +3.3        |             |             |             |             |             |
| 1970 Forecast    | ---         | ---         | ---         | ---         | 396         | 420         | 446         | 471         | 498         | 525         | 553         | 581         | 613         | 646         | 680         | 717         | 881         |
| Actual           | ---         | ---         | ---         | ---         | 398         | 429         | 460         | 481         | 491         | 506         | 546         | 581         |             |             |             |             |             |
| % Forecast Error | ---         | ---         | ---         | ---         | -0.5        | -2.1        | -3.0        | -2.1        | +1.4        | +3.8        | +1.3        | 0.0         |             |             |             |             |             |
| 1972 Forecast    | ---         | ---         | ---         | ---         | ---         | ---         | 457         | 484         | 511         | 540         | 568         | 598         | 629         | 662         | 697         | 733         | 902         |
| Actual           |             |             |             |             |             |             | 460         | 481         | 491         | 506         | 546         | 581         |             |             |             |             |             |
| % Forecast Error |             |             |             |             |             |             | -0.7        | +0.6        | +4.1        | +6.7        | +4.0        | +2.9        |             |             |             |             |             |
| 1975 Forecast    | ---         | ---         | ---         | ---         | ---         | ---         | ---         | ---         | ---         | 507         | 524         | 540         | 564         | 621         | 682         | 721         | 880         |
| Actual           |             |             |             |             |             |             |             |             |             | 506         | 546         | 581         |             |             |             |             |             |
| % Forecast Error |             |             |             |             |             |             |             |             |             | +0.2        | -4.0        | -7.1        |             |             |             |             |             |
| 1976 Forecast    |             |             | ---         | ---         | ---         | ---         | ---         | ---         | ---         | ---         | 523         | 545         | 587         | 636         | 687         | 724         | 873         |
| Actual           |             |             |             |             |             |             |             |             |             |             | 546         | 581         |             |             |             |             |             |
| % Forecast Error |             |             |             |             |             |             |             |             |             |             | -4.2        | -6.2        |             |             |             |             |             |
| 1977 Forecast    | ---         | ---         | ---         | ---         | ---         | ---         | ---         | ---         | ---         | ---         | ---         | ---         | 604         | 634         | 674         | 708         | 864         |
| % Forecast Error |             |             |             |             |             |             |             |             |             |             |             |             |             |             |             |             |             |

### NEW FORECASTING TECHNIQUES UNDER DEVELOPMENT

- . Longer Lead Times for Resource Development
- . New National Mood Regarding Energy
- . Econometric Forecasting
  - . Investigates causative factors
  - . Allows a "what if" view of the future
  - . Makes forecast more complex and requires forecasting all the input factors
  - . Requires good judgement

### A PROGRESS REPORT ON OUR NEW EFFORTS

- . Demographic and Economic Trends and Analysis
- . Counties Used for Data are Representative of Our Service Area
- . No Conclusions Yet from Preliminary Investigations
  - . Developing the mathematical correlation equations
  - . Must develop forecasts of input factors

# ELECTRIC SERVICE DIVISIONS THE MONTANA POWER COMPANY



Note: Division boundaries have been re-defined in terms of counties.

- 1 MISSOULA
- 2 BUTTE RURAL
- 3 BUTTE URBAN
- 4 HELENA

- 5 GREAT FALLS
- 6 BILLINGS
- 7 BOZEMAN

## PROGRESS REPORT ON NEW EFFORTS

### . RESIDENTIAL ELECTRIC ENERGY DEMAND - PRELIMINARY

- . Energy Demand Correlation With:
  - . Population of service area
  - . Portion of population in 20 to 30 year age group
- . Demand Has Increased With Population
- . New Homemakers (20-30 years after baby boom) Exerting Strong Pressure on Demand
  - . Expect to continue well into the 1980's

### . DATA SOURCES

- . U.S. Bureau of Census
- . Montana Department of Community Affairs
- . Montana Power Company Sales Records

# THE MONTANA POWER COMPANY RESIDENTIAL SALES & POPULATION



## PROGRESS REPORT ON NEW EFFORTS

### . RESIDENTIAL ELECTRIC ENERGY DEMAND - PRELIMINARY

#### . Energy Demand Correlation With:

- . Real per capita income
- . Real cost of electricity (400 kWh/month)

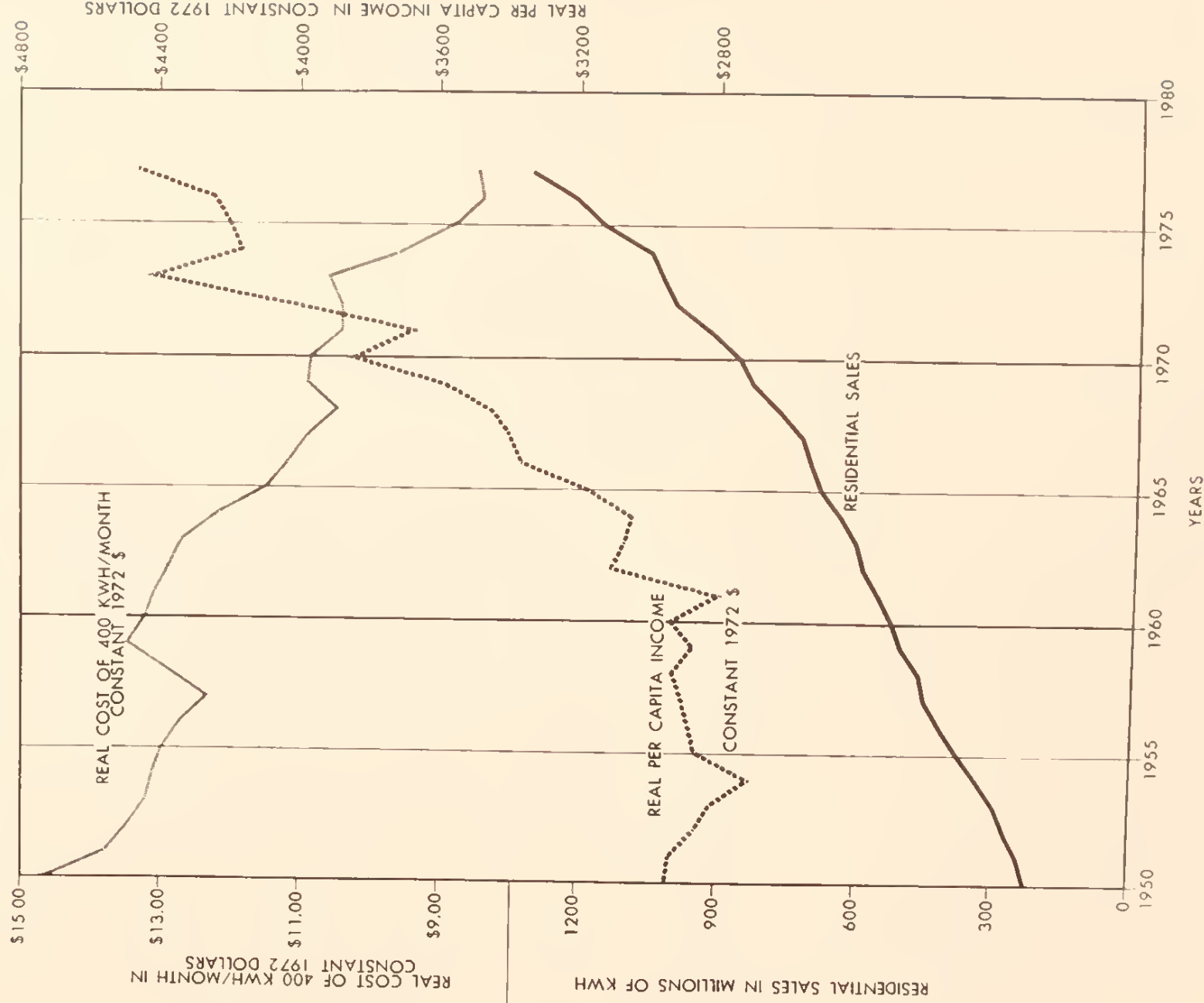
- . Real Cost of Electricity Has Declined Substantially
  - . Real Per Capita Income Has Increased Substantially
- } 1972 Dollars

### . DATA SOURCES

- . Montana Power Company Sales Records
- . Montana Power Company Rate Schedules
- . U. S. Department of Commerce, Bureau of Economic Analysis

# THE MONTANA POWER COMPANY

## RESIDENTIAL SALES, REAL COST OF ELECTRICITY, AND REAL PER CAPITA INCOME





OTHER WAYS TO SHOW DECLINING COST OF UTILITY SERVICE  
CONSTANT 1972 DOLLARS

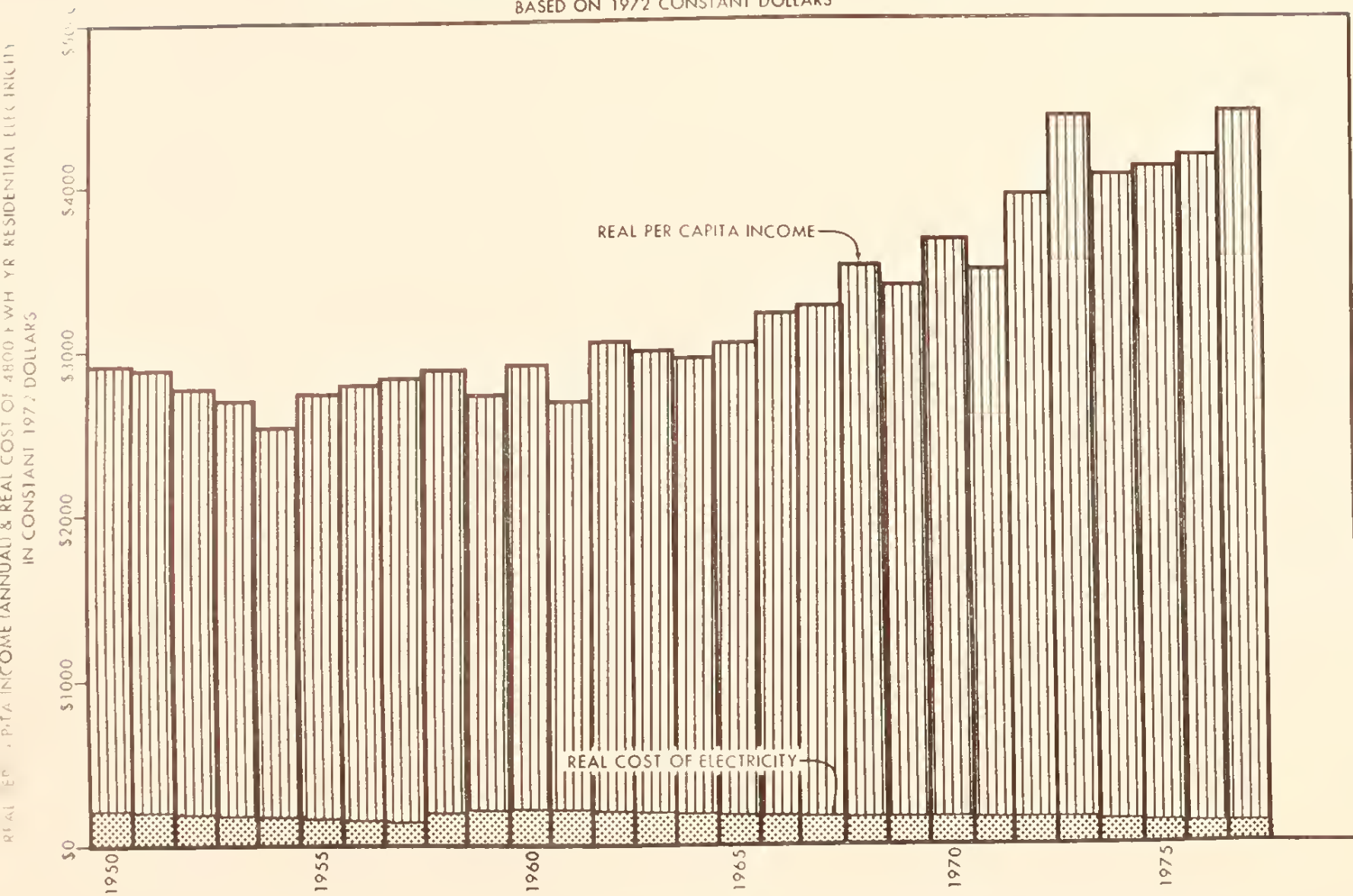
- . Real Cost of Electricity (400 kWh each month) Compared to Real Per Capita Income
  - . As a percent of Real Per Capita Income
- . Real Cost of Natural Gas (150 mcf. per year) Compared to Real Per Capita Income
  - . As a percent of Real Per Capita Income
- . Average Family Electricity and Gas Costs (average use) Compared to Average Real Family Income
  - . As a percent of Average Real Family Income

DATA SOURCES:

- . U. S. Bureau of Census
- . U. S. Department of Commerce, Bureau of Economic Analysis
- . Montana Department of Community Affairs
- . Montana Power Company Sales Records
- . Montana Power Company Rate Schedules

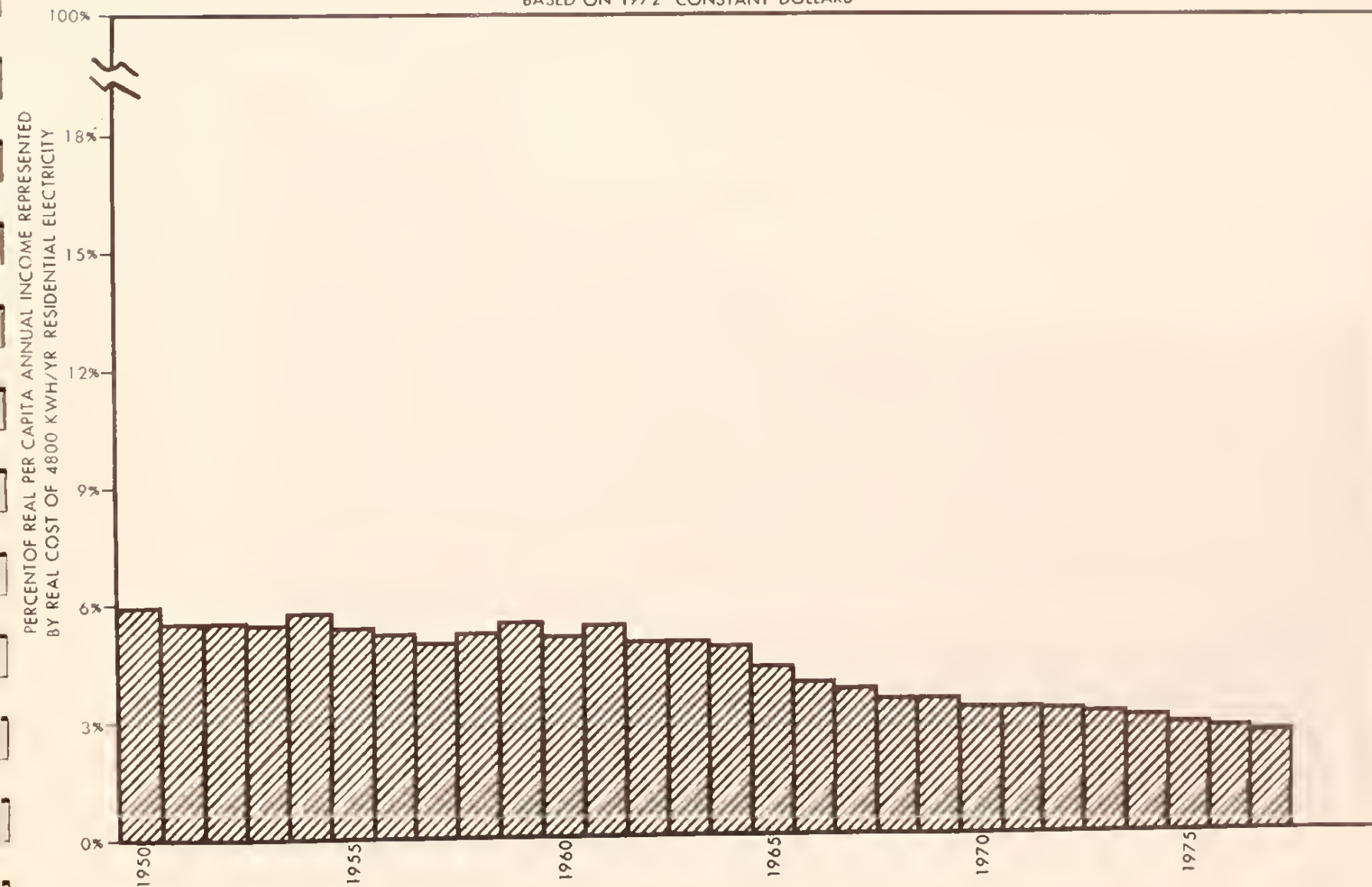
# MONTANA REAL PER CAPITA INCOME AND REAL COST OF RESIDENTIAL ELECTRICITY

BASED ON 1972 CONSTANT DOLLARS



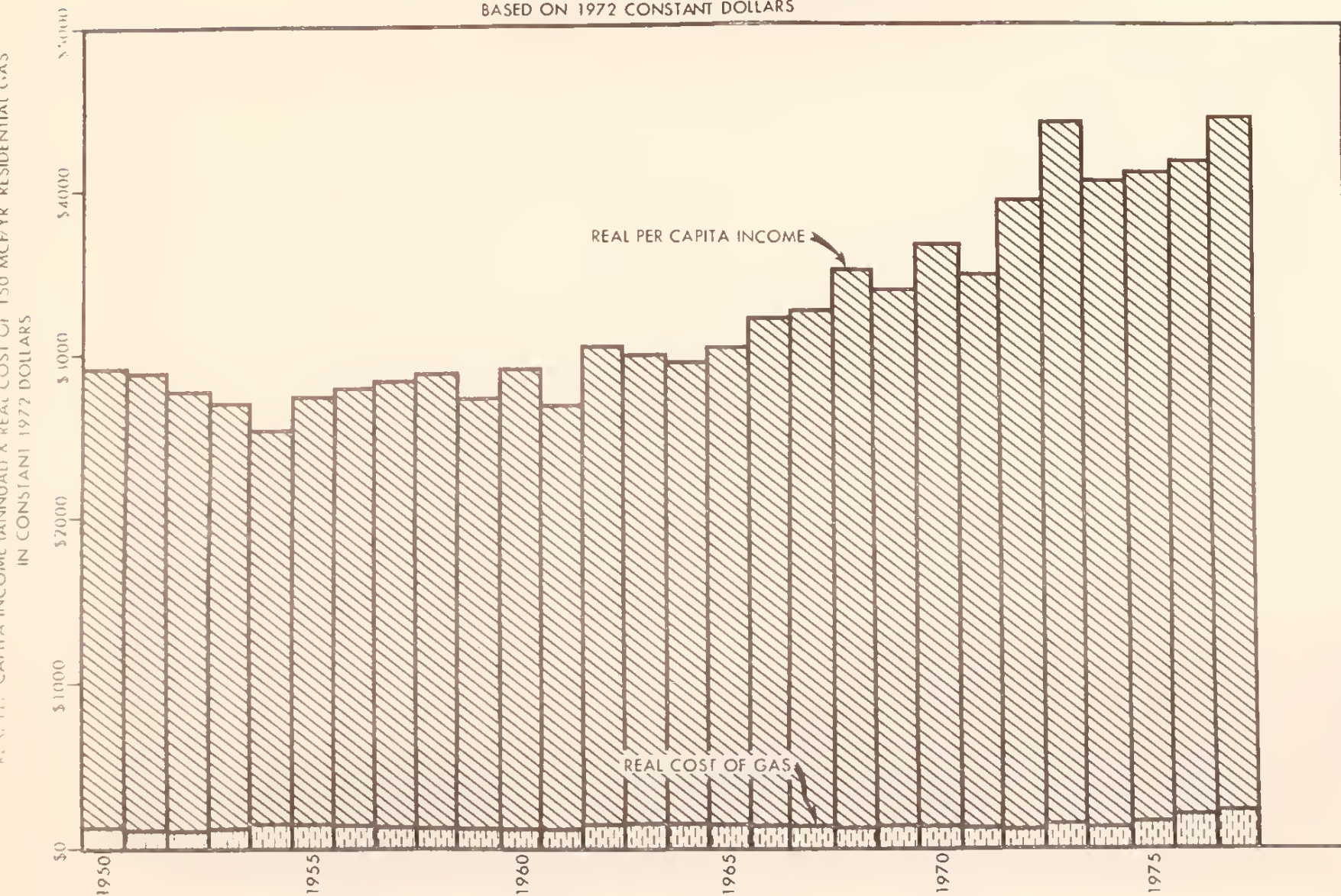
# REAL COST OF RESIDENTIAL ELECTRICITY AS A PERCENT OF REAL PER CAPITA ANNUAL INCOME

BASED ON 1972 CONSTANT DOLLARS



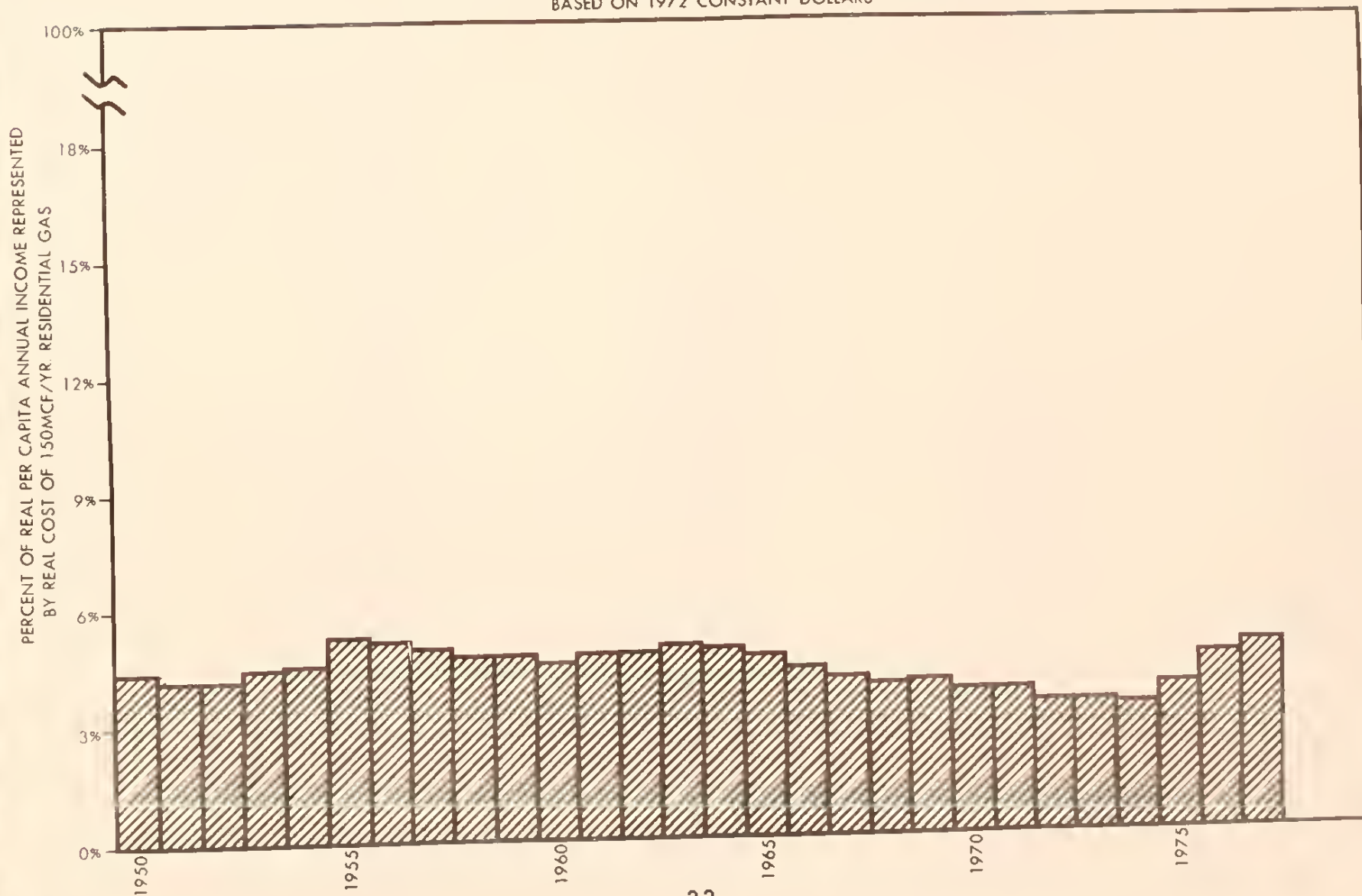
# MONTANA REAL PER CAPITA INCOME AND REAL COST OF RESIDENTIAL GAS

BASED ON 1972 CONSTANT DOLLARS

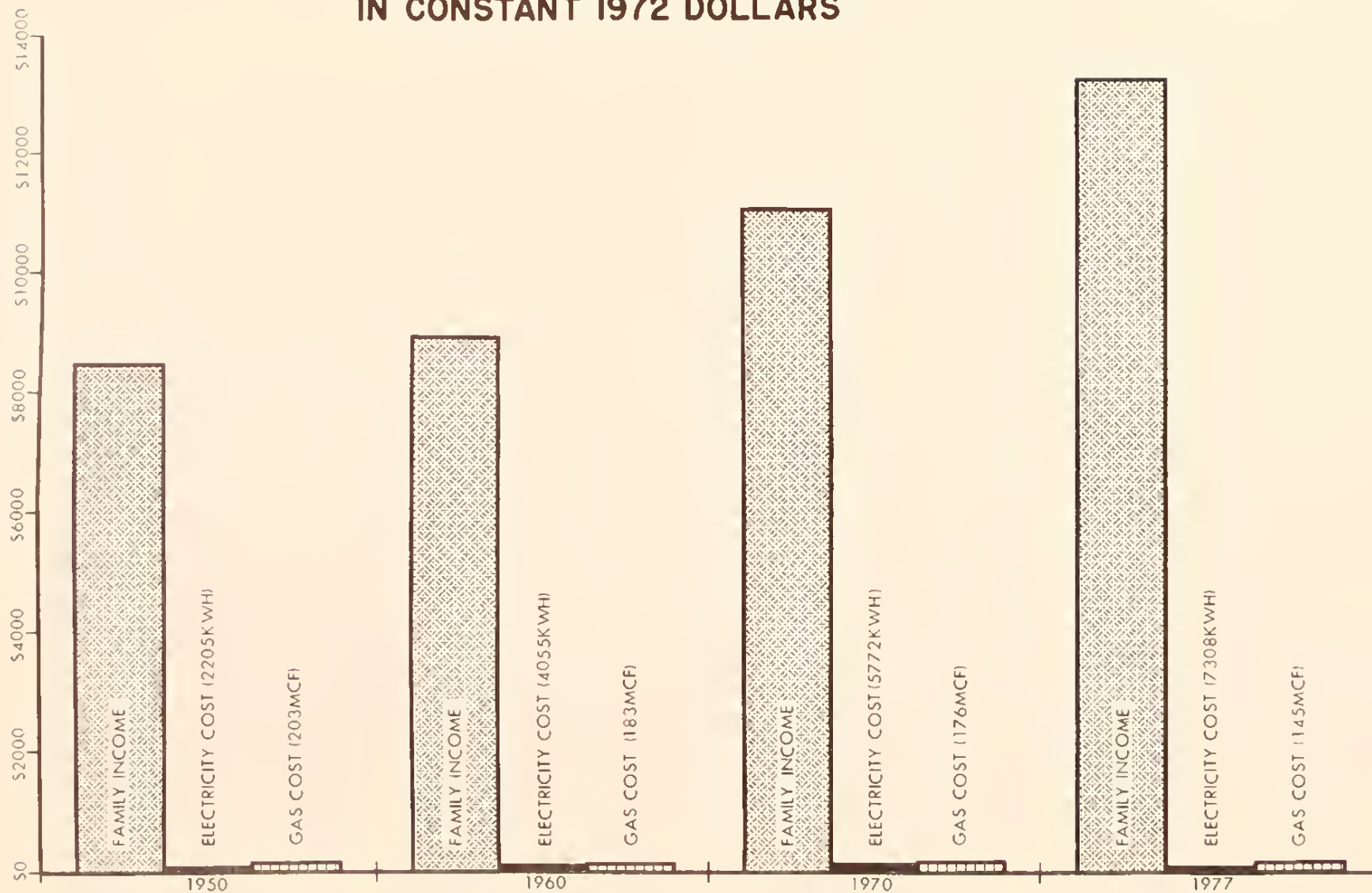


# REAL COST OF RESIDENTIAL GAS AS A PERCENT OF REAL PER CAPITA ANNUAL INCOME

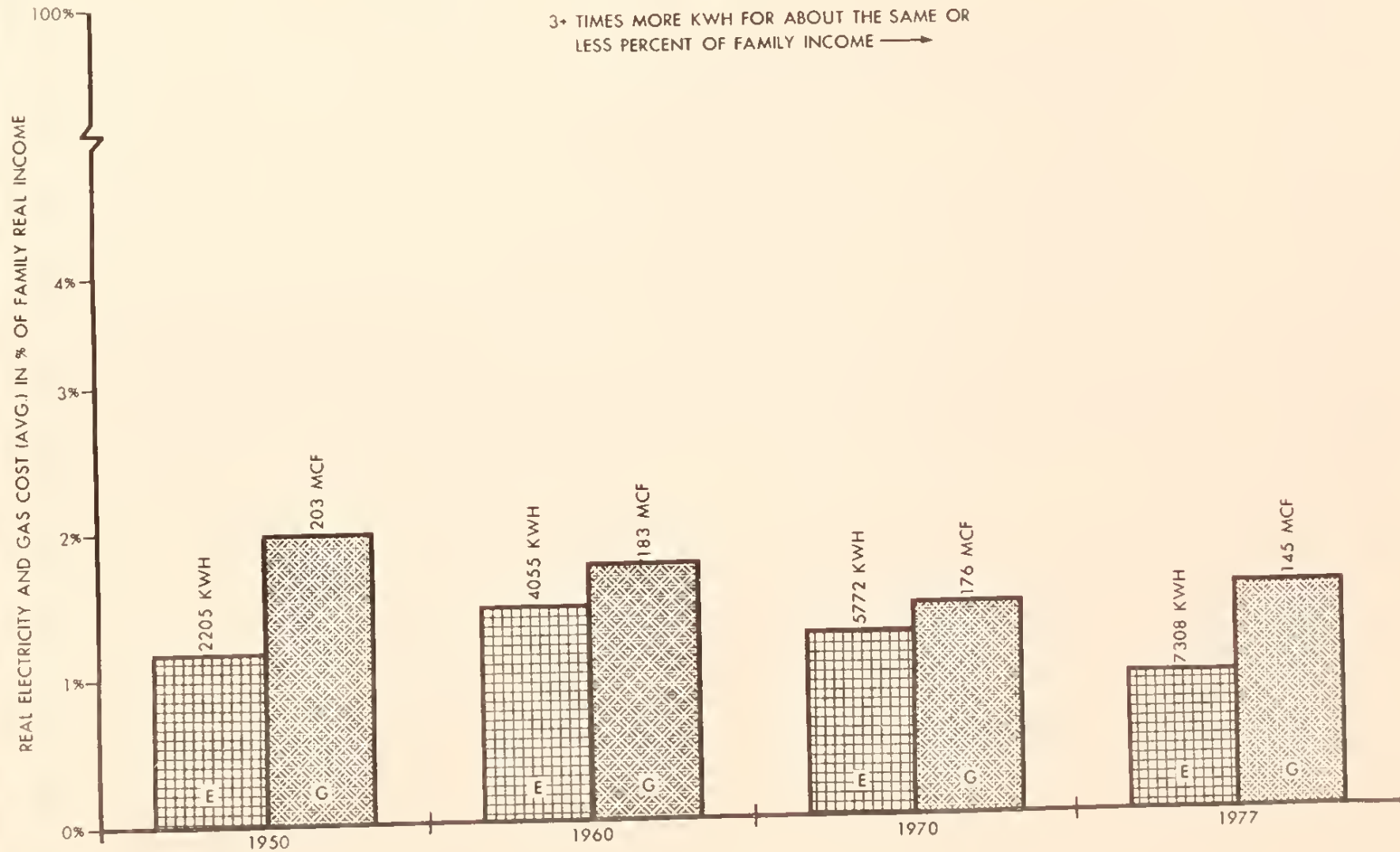
BASED ON 1972 CONSTANT DOLLARS



# **AVERAGE FAMILY REAL INCOME VS. AVERAGE RESIDENTIAL REAL UTILITY COSTS (ELECTRIC & GAS) IN CONSTANT 1972 DOLLARS**



# AVERAGE RESIDENTIAL REAL UTILITY COSTS (ELECTRIC & GAS) IN % OF AVERAGE FAMILY REAL INCOME BASED ON CONSTANT 1972 DOLLARS



PROGRESS REPORT ON NEW EFFORTS (continued)

. COMMERCIAL ELECTRIC ENERGY DEMAND - PRELIMINARY

. Energy Demand Correlation With:

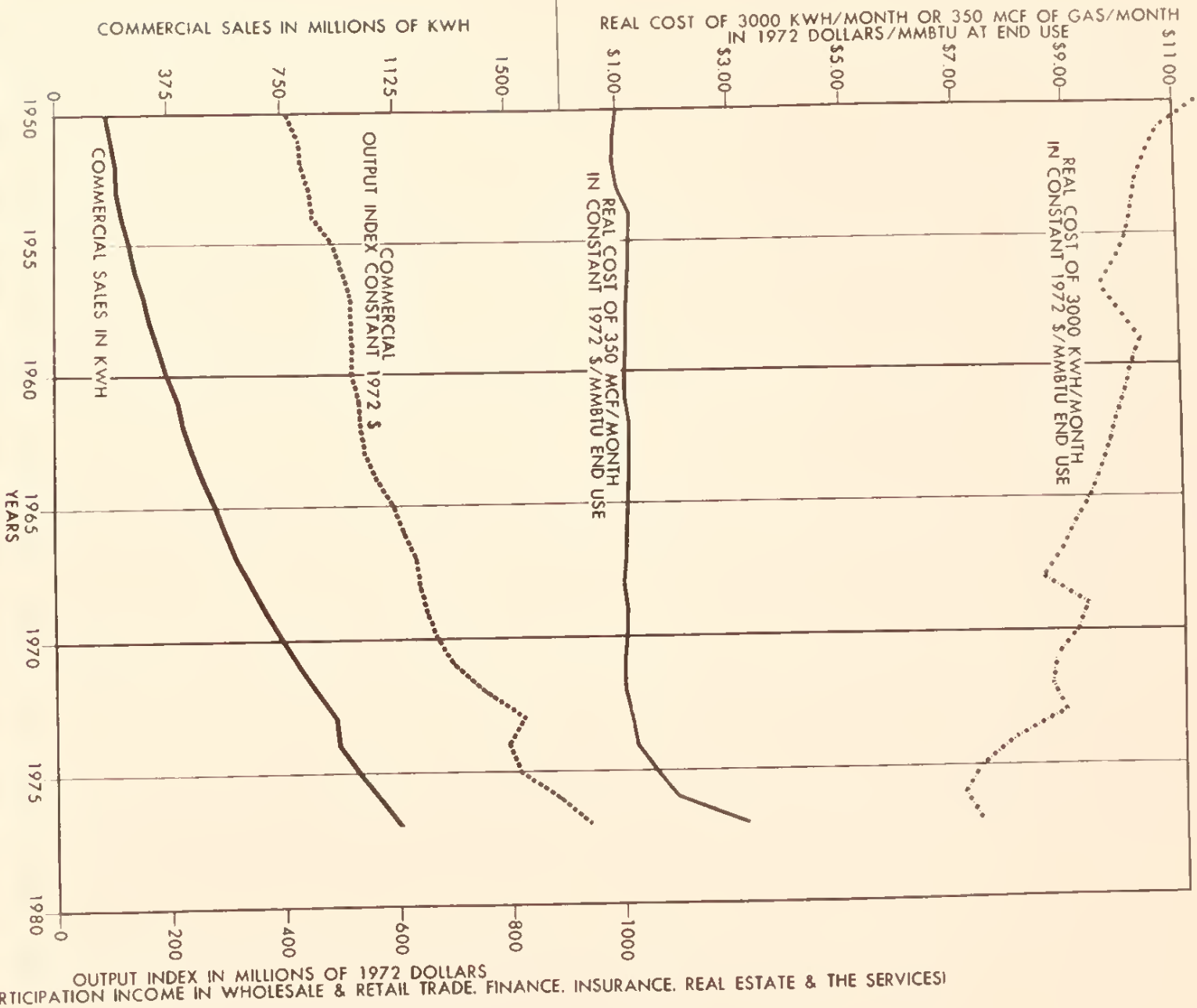
- . Commercial Output Index (Wage, salaries, proprietors' income and labor income in wholesale & retail trade, finance, insurance, real estate, and the services) - 1972 Dollars
  - . Real Cost of Electricity (3000 kWh/month)
  - . Real Cost of Natural Gas (350 mcf./month)
- } 1972 Dollars

- . Demand Has Increased With Output
- . Real Cost of Electricity Has Declined Substantially
- . Real Cost of Gas Has Increased Recently But Lag Time For Conversion to Electric is Probably Substantial

. DATA SOURCES

- . U. S. Department of Commerce, Bureau of Economic Analysis
- . Montana Power Company Sales Records
- . Montana Power Company Rate Schedules

# THE MONTANA POWER COMPANY COMMERCIAL SALES, REAL COST OF ELECTRICITY & NATURAL GAS, & COMMERCIAL OUTPUT INDEX



## PROGRESS REPORT ON NEW EFFORTS (continued)

### . SMALL INDUSTRIAL ELECTRIC ENERGY DEMAND - PRELIMINARY

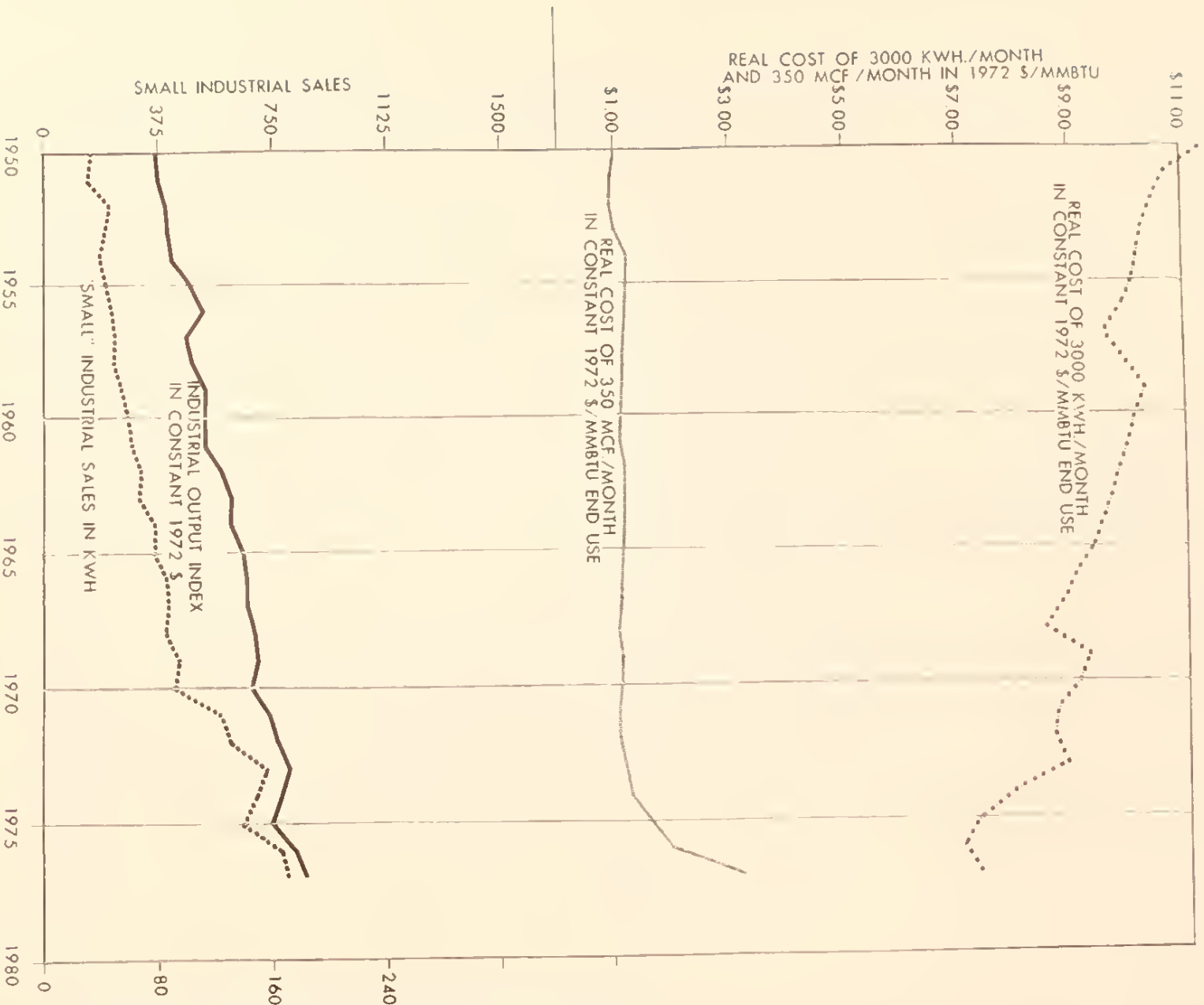
#### . Energy Demand Correlation With:

- . Industrial Output Index (wages, salaries, proprietors' income and labor income in manufacturing - excluding primary metals refining, oil refining, and paper products) - 1972 Dollars
  - . Real Cost of Electricity (3000 kWh/month)
  - . Real Cost of Natural Gas (350 mcf/month)
- } 1972 Dollars
- . Demand Has Increased With Output
  - . Real Cost of Electricity Has Declined Substantially
  - . Real Cost of Gas Has Increased Recently But Lag Time For Conversion to Electric is Probably Substantial

### . DATA SOURCES

- . U. S. Department of Commerce, Bureau of Economic Analysis
- . Montana Power Company Sales Records
- . Montana Power Company Rate Schedules

# THE MONTANA POWER CO. "SMALL" INDUSTRIAL SALES, REAL COST OF ELECTRICITY AND NATURAL GAS, AND INDUSTRIAL OUTPUT INDEX



OUTPUT INDEX IN MILLIONS OF 1972 DOLLARS ( PARTICIPATION  
 INCOME IN MANUFACTURING. EXCLUDING PRIMARY METALS  
 REFINING. OIL REFINING AND PAPER PRODUCTS )

## CURRENT ENERGY LOAD FORECAST ELEMENTS

### . RESIDENTIAL LOADS

#### . 4.707% Historical Growth Per Year

##### . Last three years higher growth than long term despite conservation

##### . Possible causes

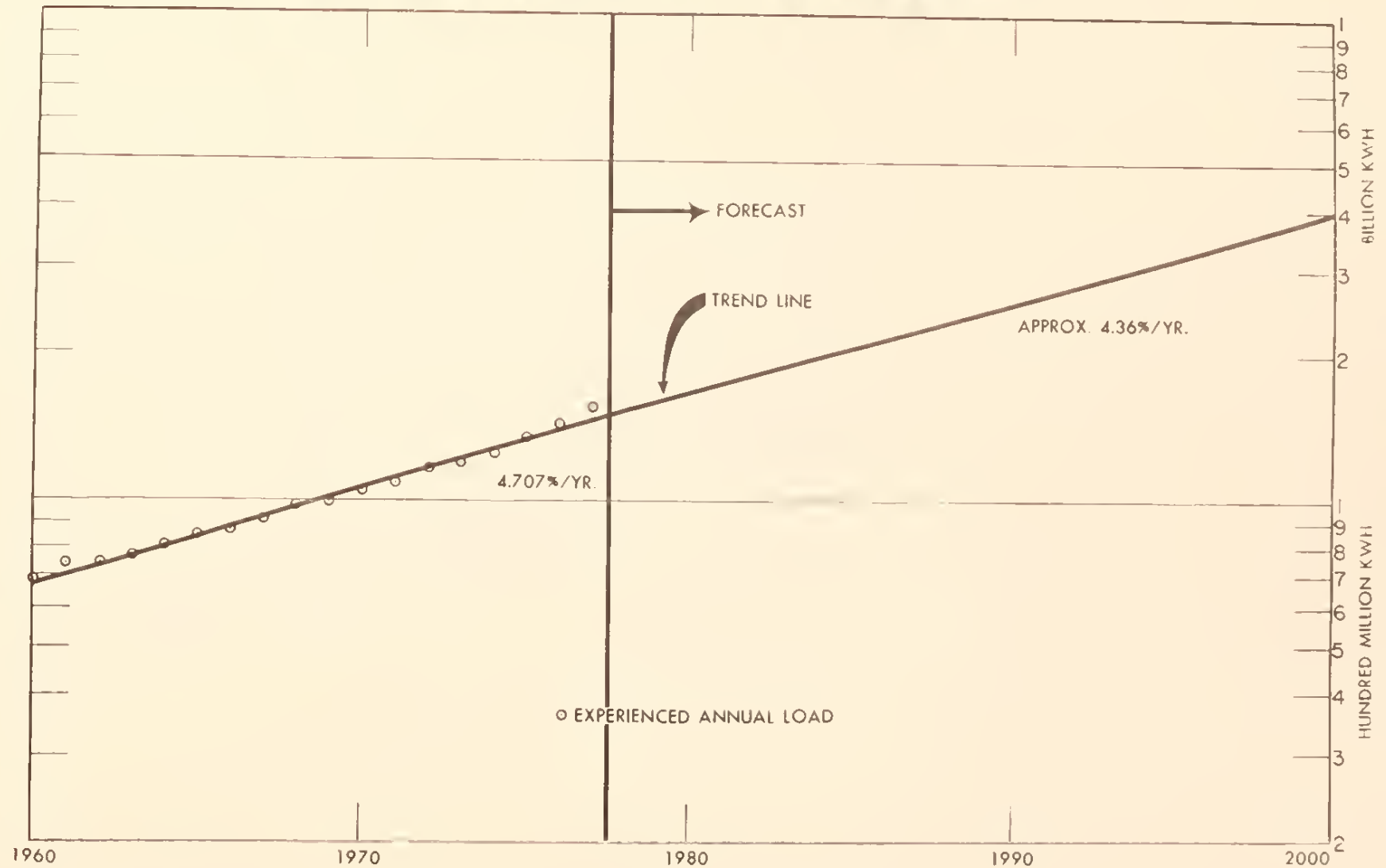
- . declining real cost of electricity
- . dramatic shift to electric heat
- . large influx of new homemakers

#### . 4.36% Forecast Growth Rate

##### . Factors

- . Strong conservation efforts
- . Gas story diminishing push for electric heat
- . Baby boom moderating in mid-1980's
- . Some solar heat applications

# ANNUAL RESIDENTIAL LOAD (SALES & ALLOCATED LOSSES)

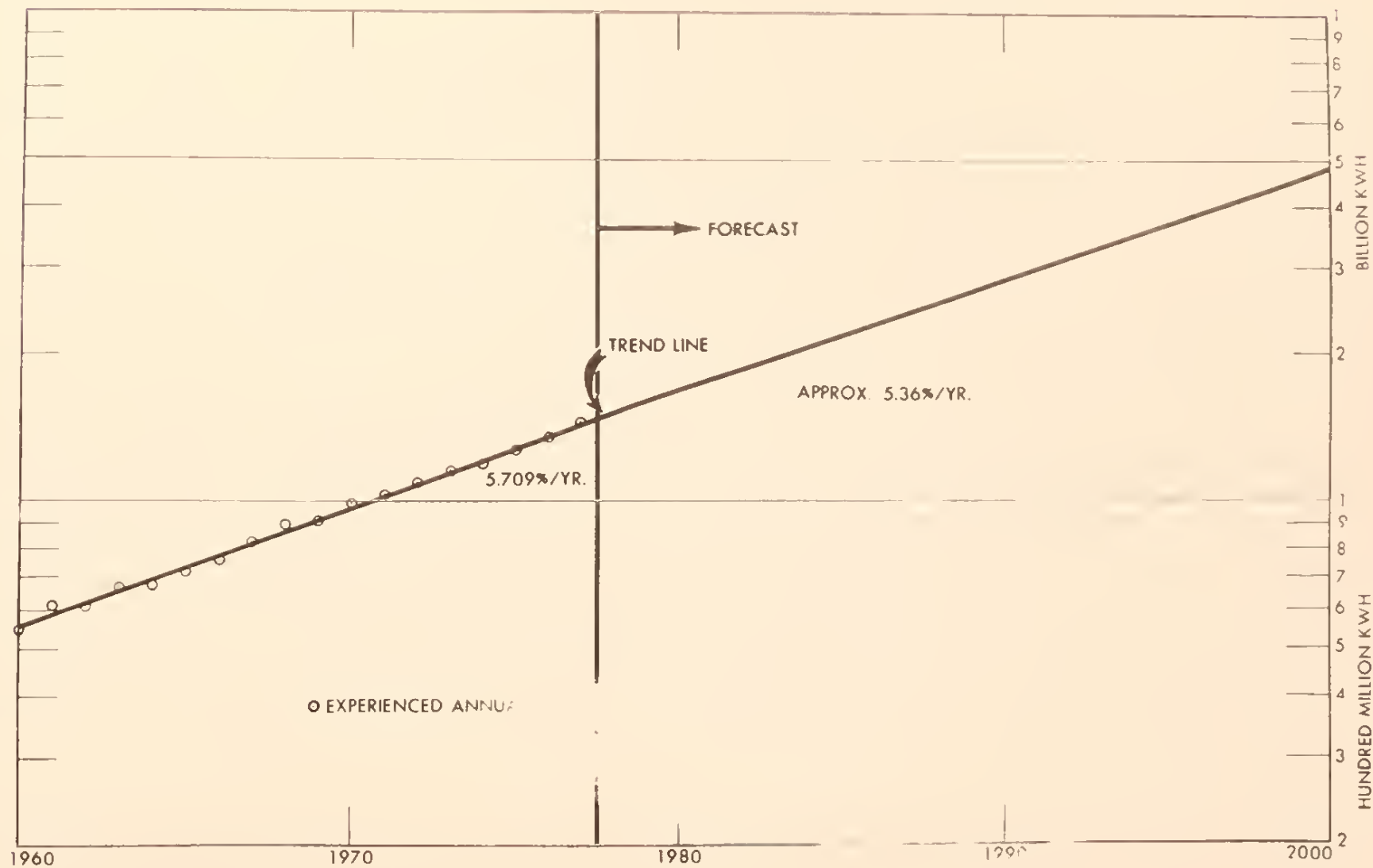


## CURRENT ENERGY LOAD FORECAST ELEMENTS - 2

### . COMMERCIAL LOADS

- . 5.709% Historical Growth Per Year
  - . Most Stable Historical Pattern
- . 5.36% Forecast Growth Rate
  - . Increasing Factors
    - . Switch from petroleum to electric energy
    - . Pollution cleanup
    - . Electric delivery vans
  - . Decreasing Factors
    - . Strong conservation effort & opportunity
    - . Solar heat
    - . Rising real cost of electricity in future

# ANNUAL COMMERCIAL, STREET & HIGHWAY LIGHTING & INTERDEPARTMENT LOAD (SALES & ALLOCATED LOSSES)

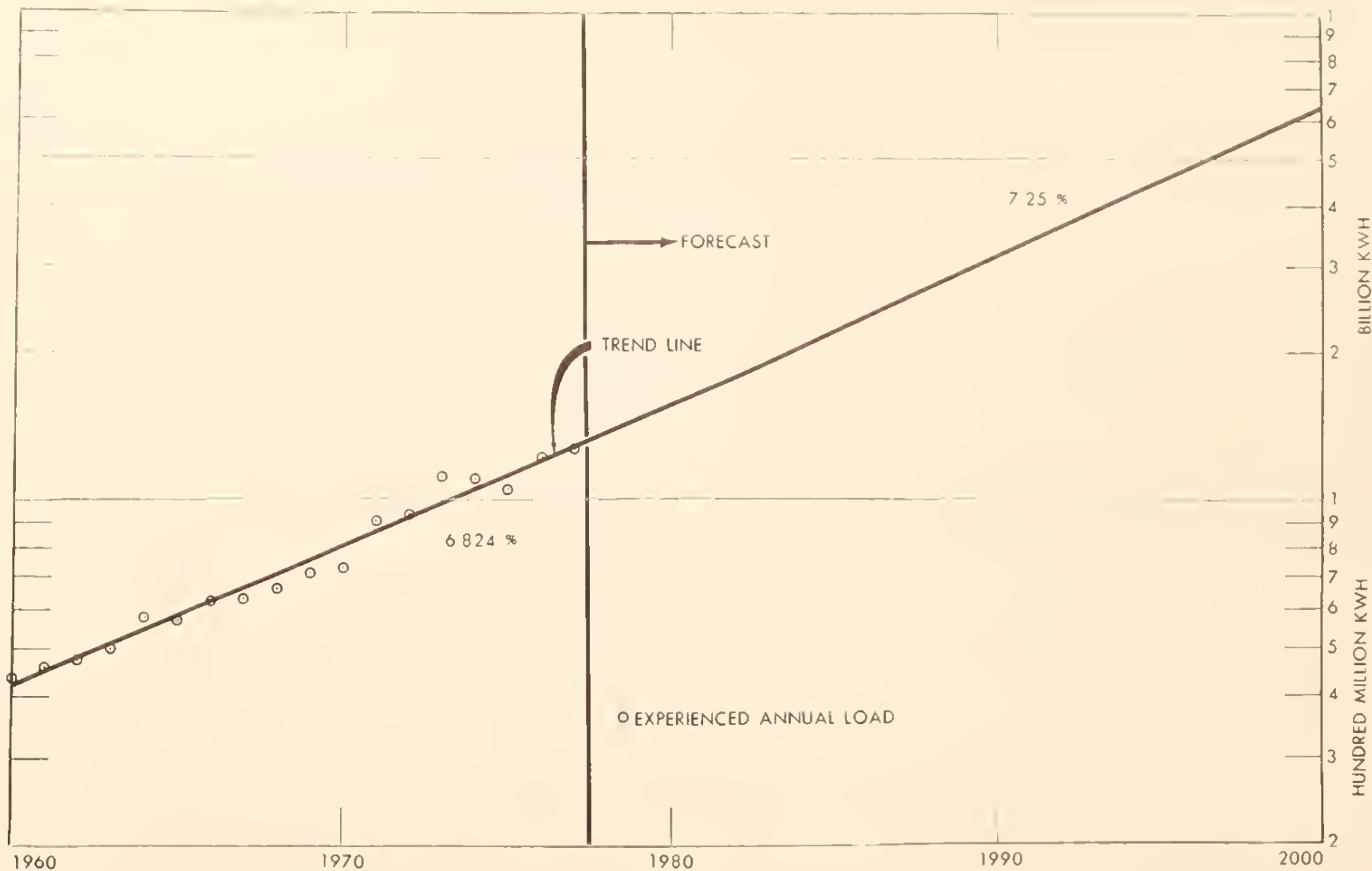


## CURRENT ENERGY LOAD FORECAST ELEMENTS - 3

### . SMALL INDUSTRIAL LOADS

- . 6.824% Historical Growth Per Year
  - . Most Volatile Group
    - . Probably most price responsive group
    - . Already have conserved to their economic limit
- . 7.25% Forecast Growth Rate
  - . Increasing Factors
    - . Switch from petroleum to electric energy
    - . Pollution cleanup
    - . Sprinkler irrigation
    - . Mineral extraction & processing
    - . Pipeline pumping
  - . Decreasing Factors
    - . Rising real cost of electricity in future
    - . Solar heat applications
    - . Co-generation (limited opportunities)

# ANNUAL INDUSTRIAL LOAD (SALES & ALLOCATED LOSSES) EXCLUDING ANA.CO., HOERNER-WALDORF & EXXON



CURRENT ENERGY LOAD FORECAST ELEMENTS - 4

. RUPAL ELECTRIC CO-OP LOAD

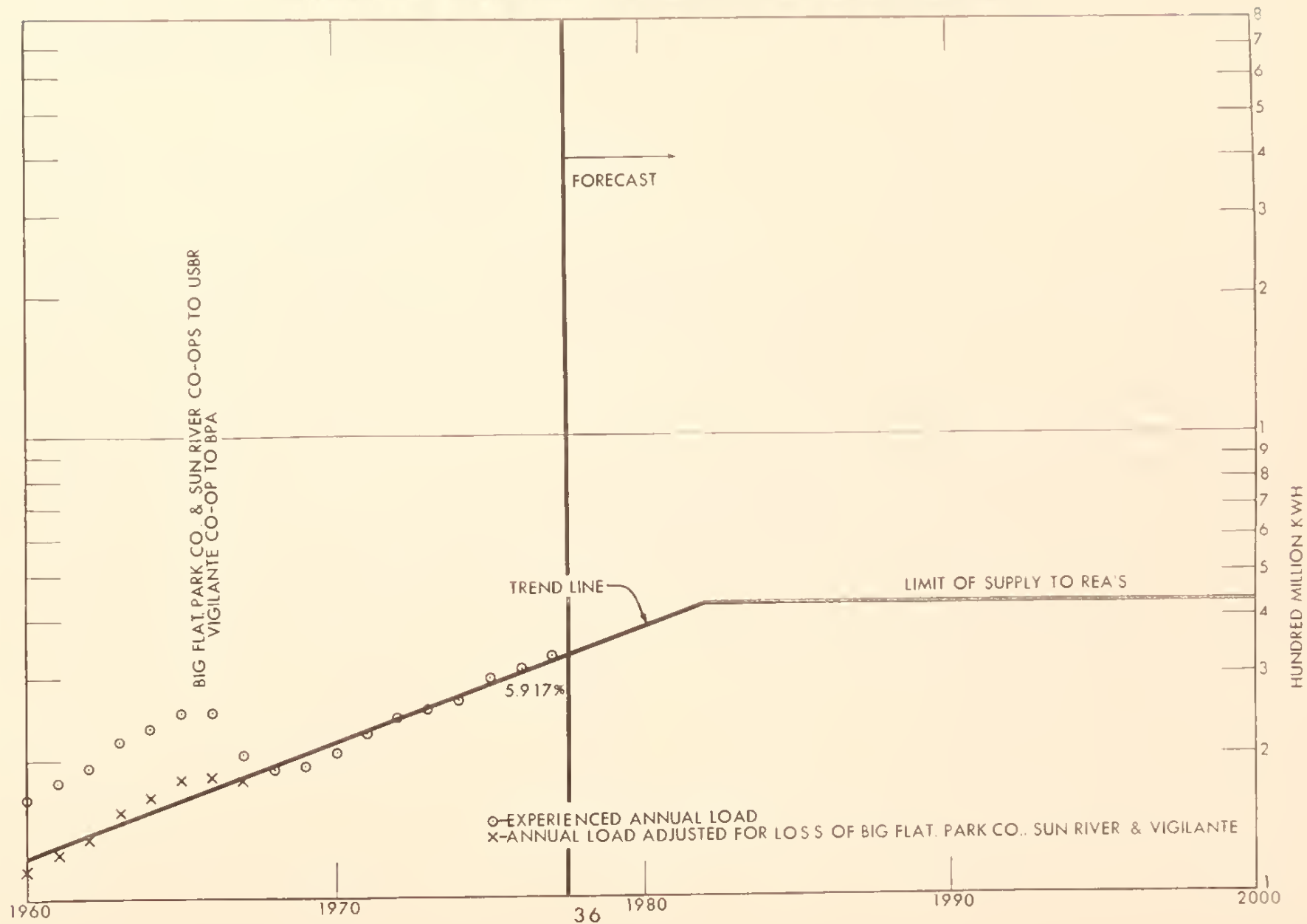
. 5.917% Historical Growth Per Year

- . History adjusted to reflect USBR & BPA taking over some of this service in mid-60's

. 5.92% Forecast Growth Rate

- . Only until 1982
- . Growth thenceforth not served by Montana Power Company

# ANNUAL RURAL ELECTRIC COOPERATIVE LOAD (SALES & ALLOCATED LOSSES)



## CURRENT ENERGY LOAD FORECAST ELEMENTS - 5

### . LARGE INDUSTRIAL LOADS

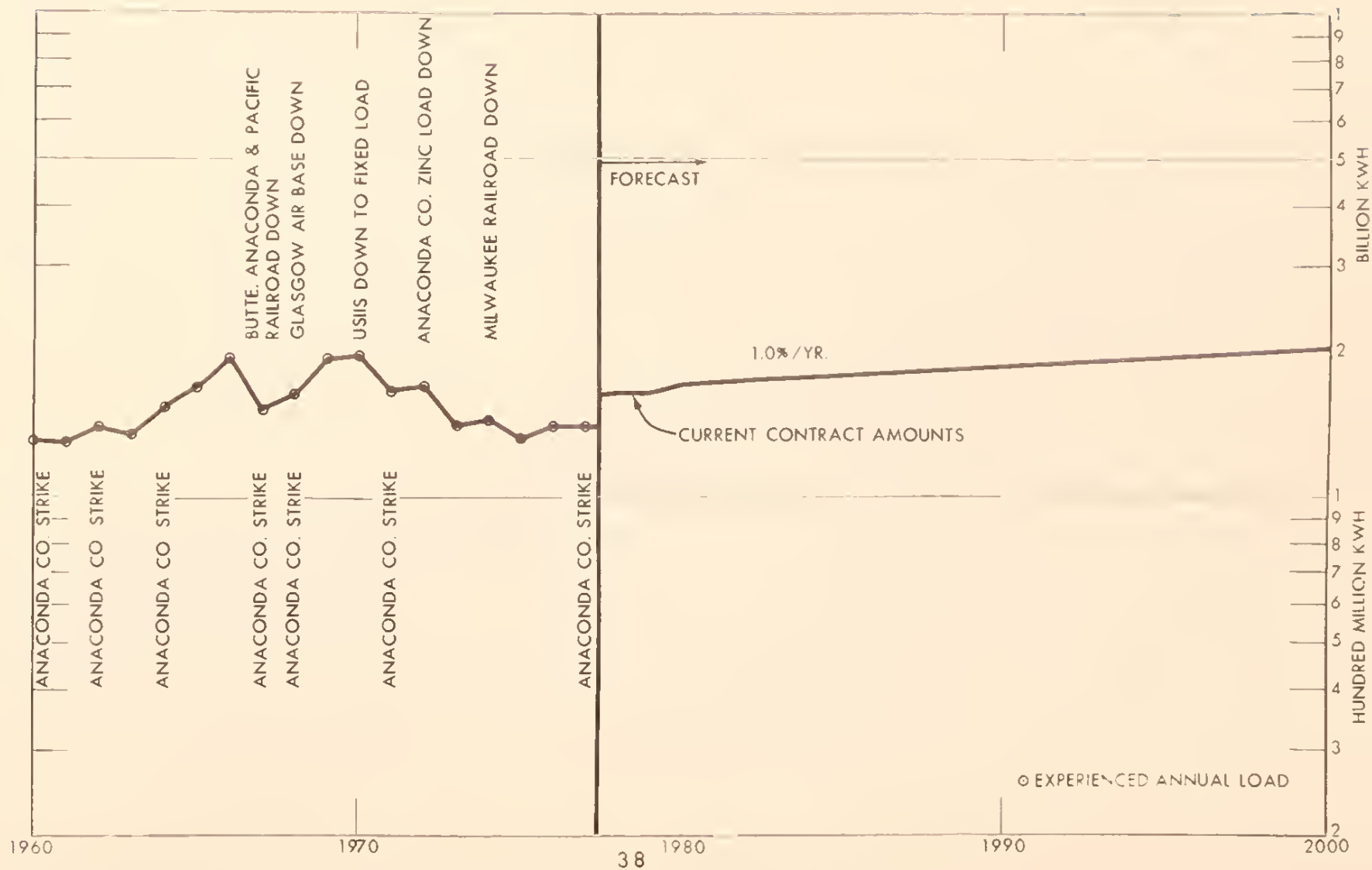
#### . Past Growth Pattern Not Trendable

- . Anaconda Company
- . Hoerner-Waldorf
- . Exxon
- . U. S. Indian Irrigation Service
- . U. S. Air Base and Missile loads
- . Electric railroads

#### . Future Growth

- . USIIS - fixed load
- . Electric railroad load - terminated
- . Forecast allows for growth of group at 1% per year

# LARGE INDUSTRIAL, USIIS, MILITARY AND RAILROAD SALES

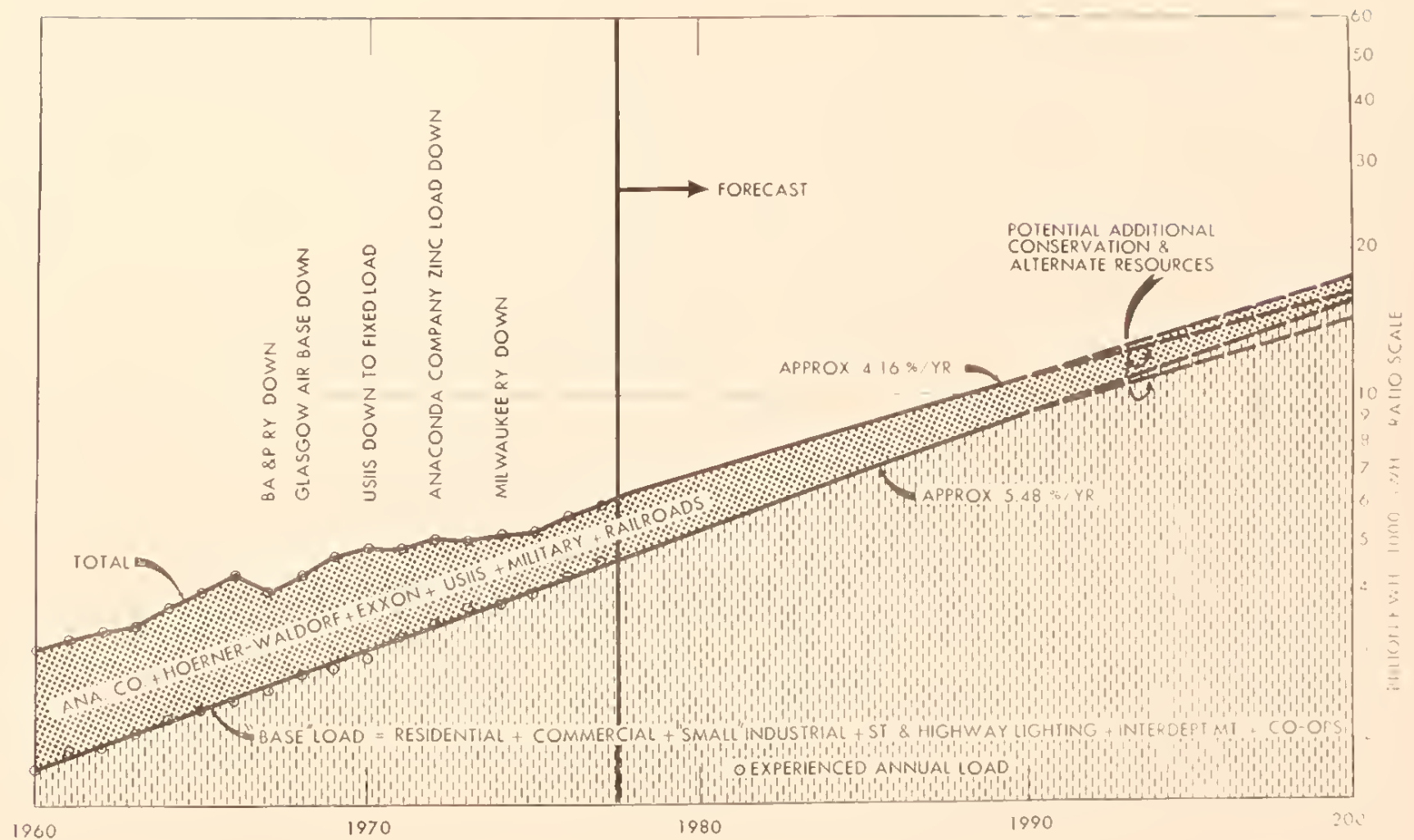


CURRENT ENERGY LOAD FORECAST ELEMENTS - 6

. TOTAL SYSTEM LOADS

- . Load For Which We Must Provide Resources
  - . kWh divided by 8760 hours/year equals avg. energy load forecast filed with DNR in April
  - . "Base" Loads - 5.48% Per Year Forecasted Growth Rate
    - . Composite of Residential, Commercial, Small Industrial, Street & Highway Lighting, Interdepartmental and Co-ops
  - . Total Loads - 4.16% Per Year Forecasted Growth Rate
    - . Base Load Plus Large, Non-conforming Loads
- . Potential For Additional Conservation and Alternate Resources
  - . After 1990 Might Reduce Growth as Shown
    - . Assumes additional 15% conservation in "base" loads

# ANNUAL TOTAL LOAD & ANNUAL "BASE" LOAD- ENERGY- (SALES & LOSSES)



OTHER FORECASTS REQUIRED - NOT ILLUSTRATED HERE

. MONTHLY ENERGY LOADS

- . Based on Annual Forecast and Historical Trend Analysis

. MONTHLY PEAK LOADS

- . Based on Energy Forecasts and Historical Trend Analysis

. Ratio of Avg. Energy and Annual Peak equals Load Factor

- . Forecasted to Increase Perceptibly

- . Irrigation load - summer

- . Air conditioning load - summer

- . Impact of solar heat - winter

- . Impact of national efforts in load management, time of day, pricing, etc.

- . Shifts energy to another part of day but does not reduce energy requirement

## SUMMARY

- . World Social and Economic Change - Changing Energy Patterns
  - . Heavy Impact on Utility Industry
    - . Energy demands ever-increasing
    - . Costs rising at unprecedented rates
    - . Lead time for new resources ever-longer
    - . Environmental issues ever-more complex
  - . Goal of Providing Good, Reliable, Low-cost Energy Service
    - . Requires Optimizing Resource Mix
    - . Depends on Good Forecasts of Load
      - . Have been good
      - . Can be better
      - . Must factor in the effects of conservation, load-management, alternate energy



U. S. AND MONTANA ENERGY OVERVIEW

ALTERNATIVE ENERGY

CONSERVATION

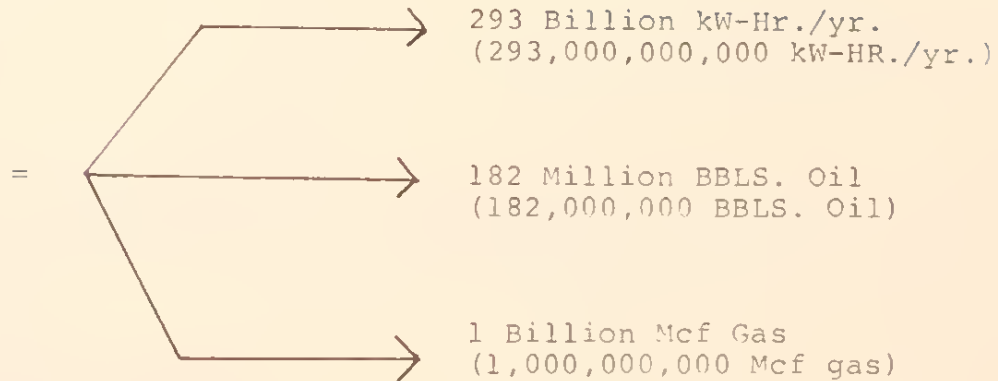
## NEW DIRECTIONS IN ENERGY

- . U.S. AND MONTANA ENERGY: A LOOK AT THE FUTURE
  - . CONSERVATION AND ALTERNATIVE ENERGY OUTLOOK
  - . U.S. AND MONTANA CONSUMPTION/PRODUCTION 1977
  - . NATIONAL ACADEMY OF SCIENCE
    - . U.S. ENERGY OUTLOOK TO 2010 - FOUR SCENARIOS
    - . THE CHOICES
    - . IMPLICATIONS FOR THE FUTURE
    - . WHAT IT MEANS
- . ALTERNATIVE ENERGY OUTLOOK
  - . WIND ENERGY OUTLOOK
    - . MEDICINE BOW PROJECT
    - . MPC'S WIND PROJECTS
    - . WIND MACHINE COSTS
  - . SOLAR OUTLOOK
    - . U.S. ENERGY
    - . U.S. AND MONTANA SOLAR OUTLOOK
    - . MPC'S SOLAR PROJECT
- . SUMMARY

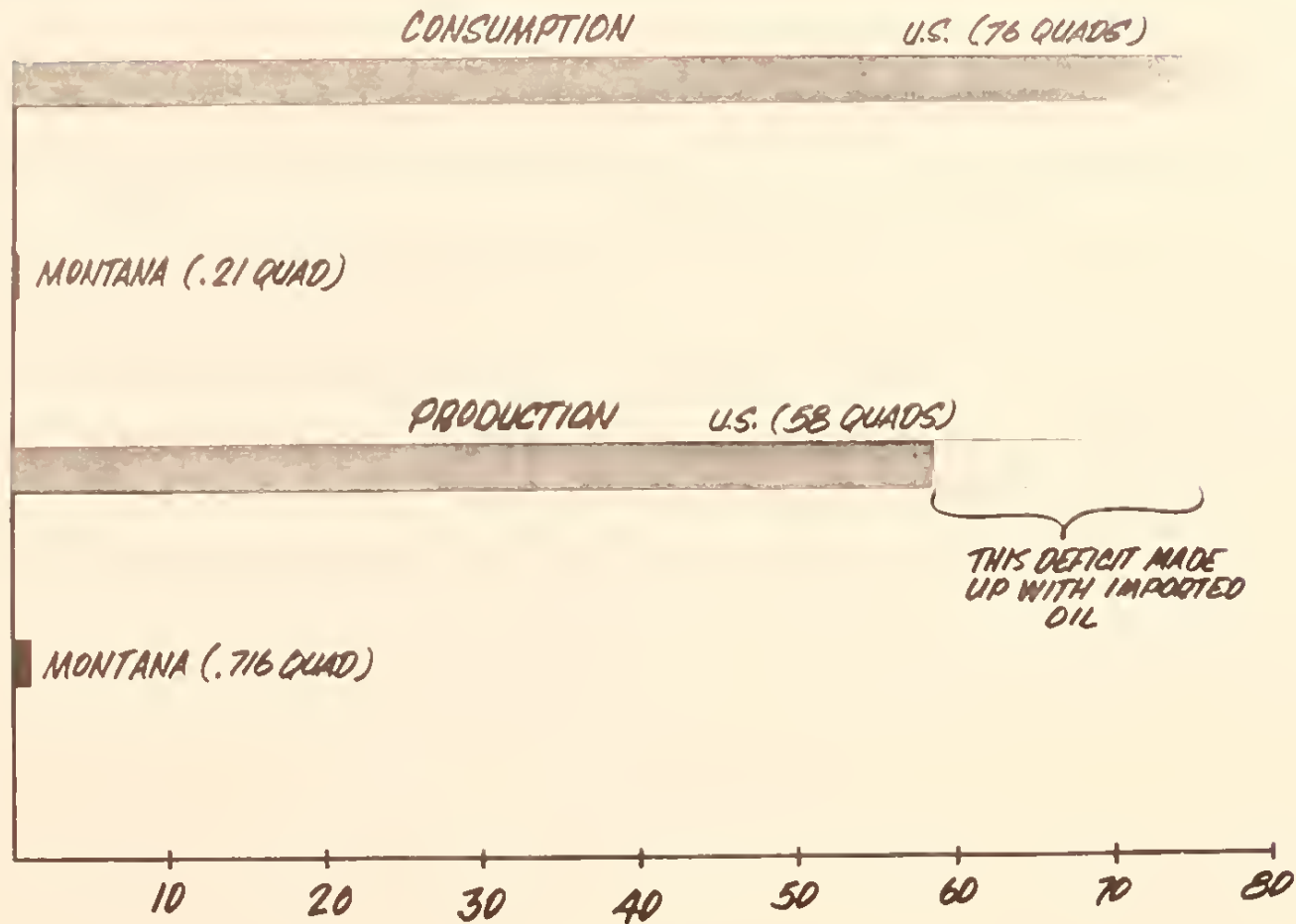
ENERGY MEASUREMENT TERMS

1 QUAD  
(1 Quadrillion BTU's)

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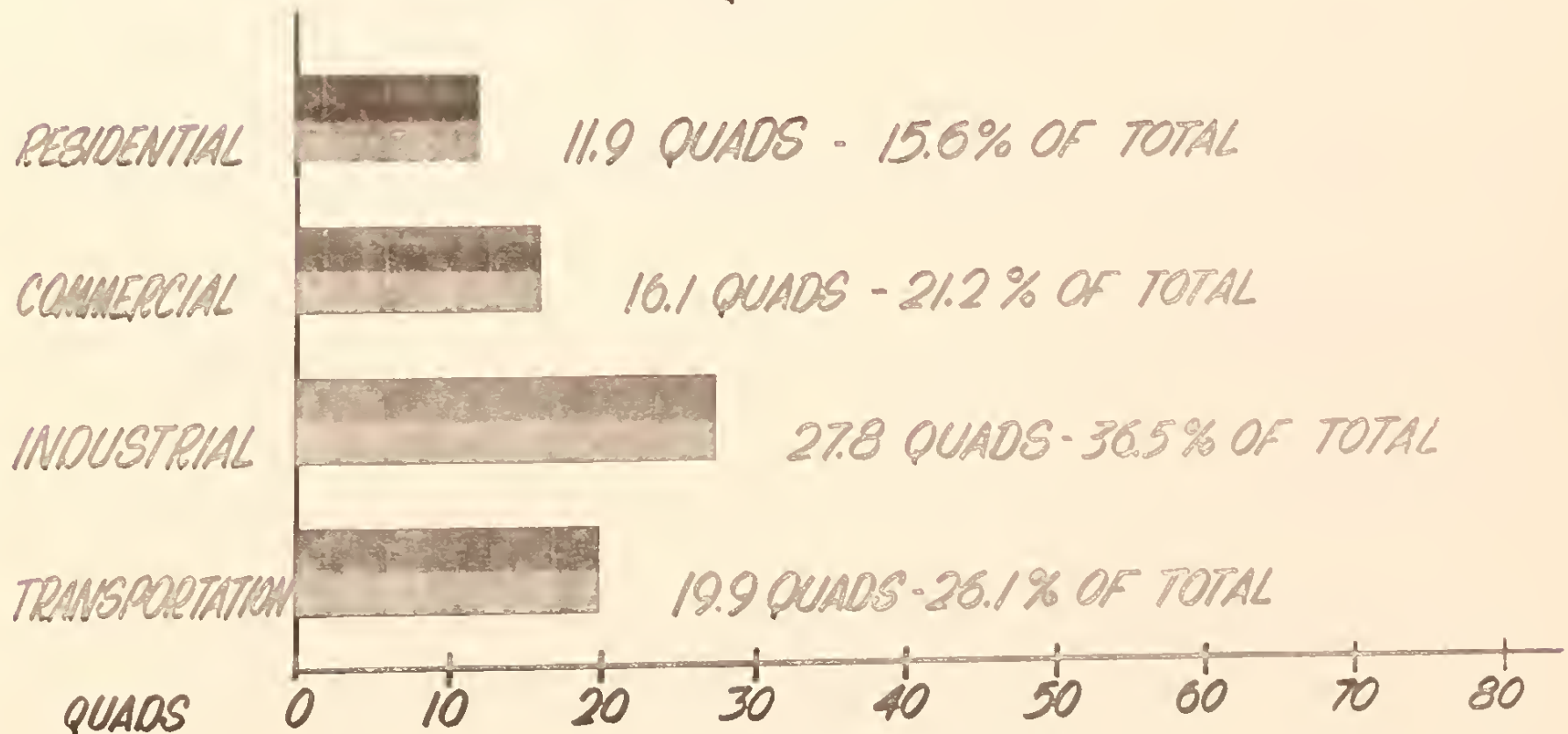


# U.S. & MONTANA ENERGY CONSUMPTION & PRODUCTION 1977



# U.S. ENERGY CONSUMPTION BY SECTOR 1977

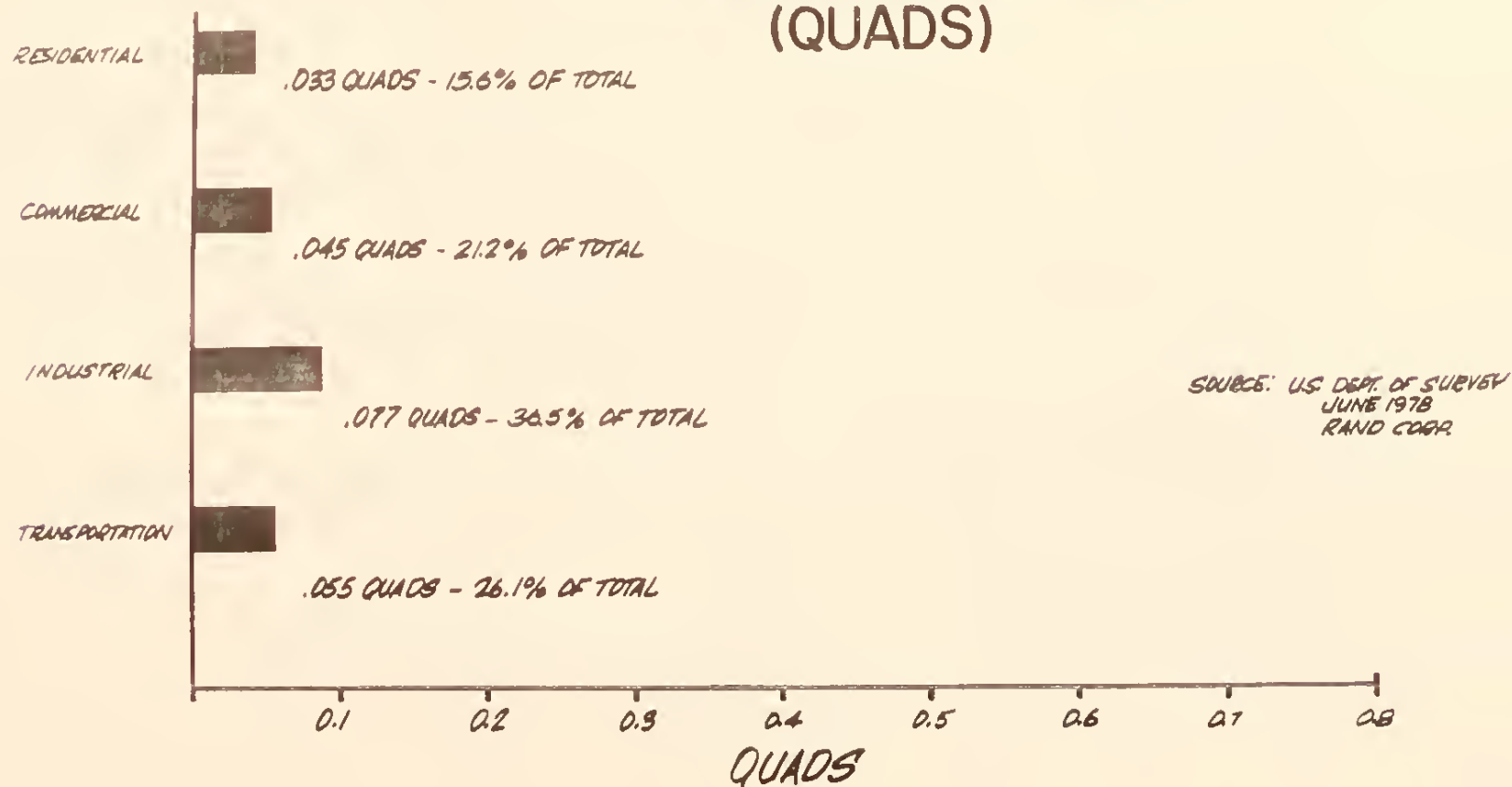
RESIDENTIAL, COMMERCIAL, INDUSTRIAL, TRANSPORTATION  
- QUADS -

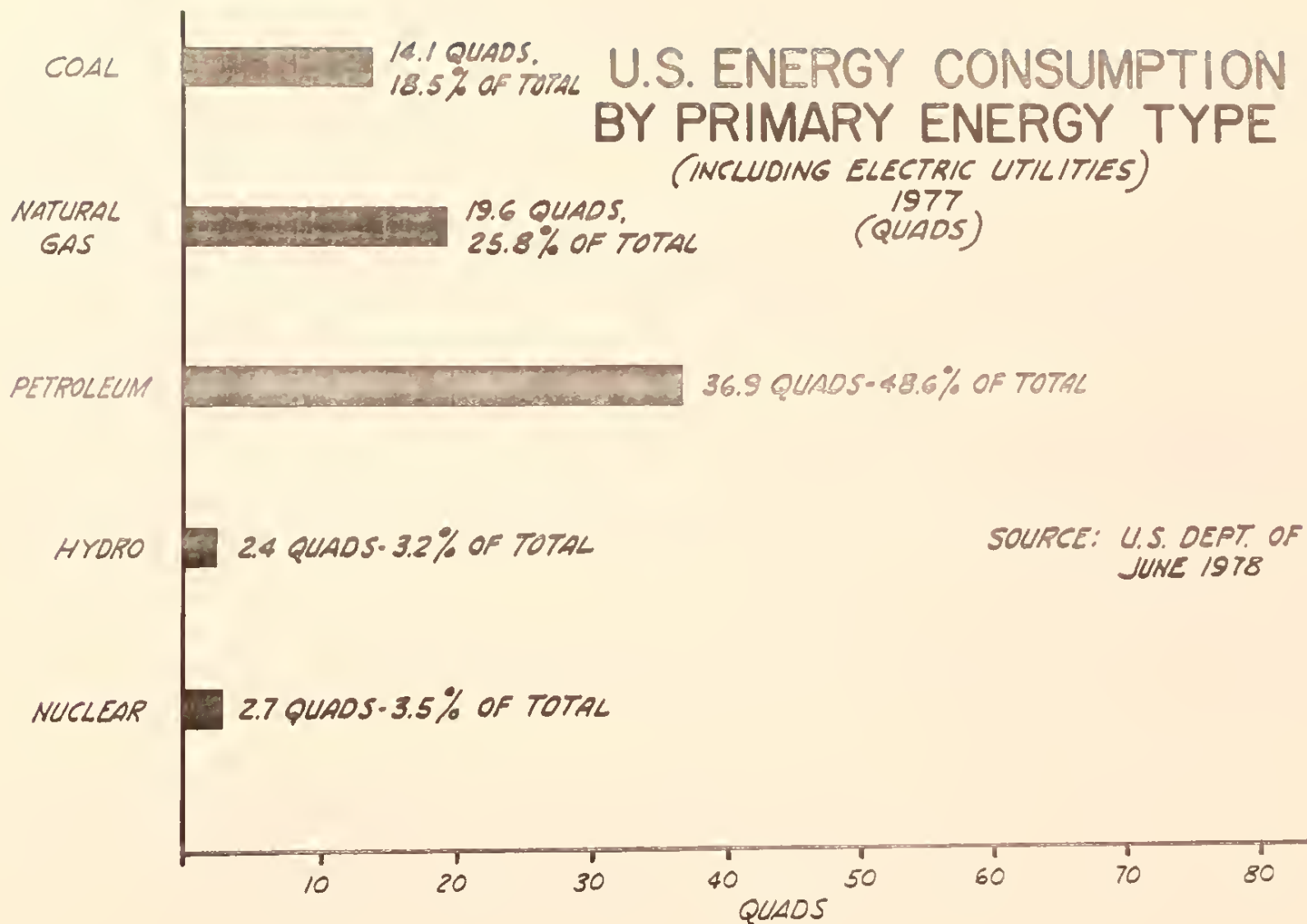


SOURCE: U.S. DEPT. OF ENERGY, JUNE 1968. RANC CORR

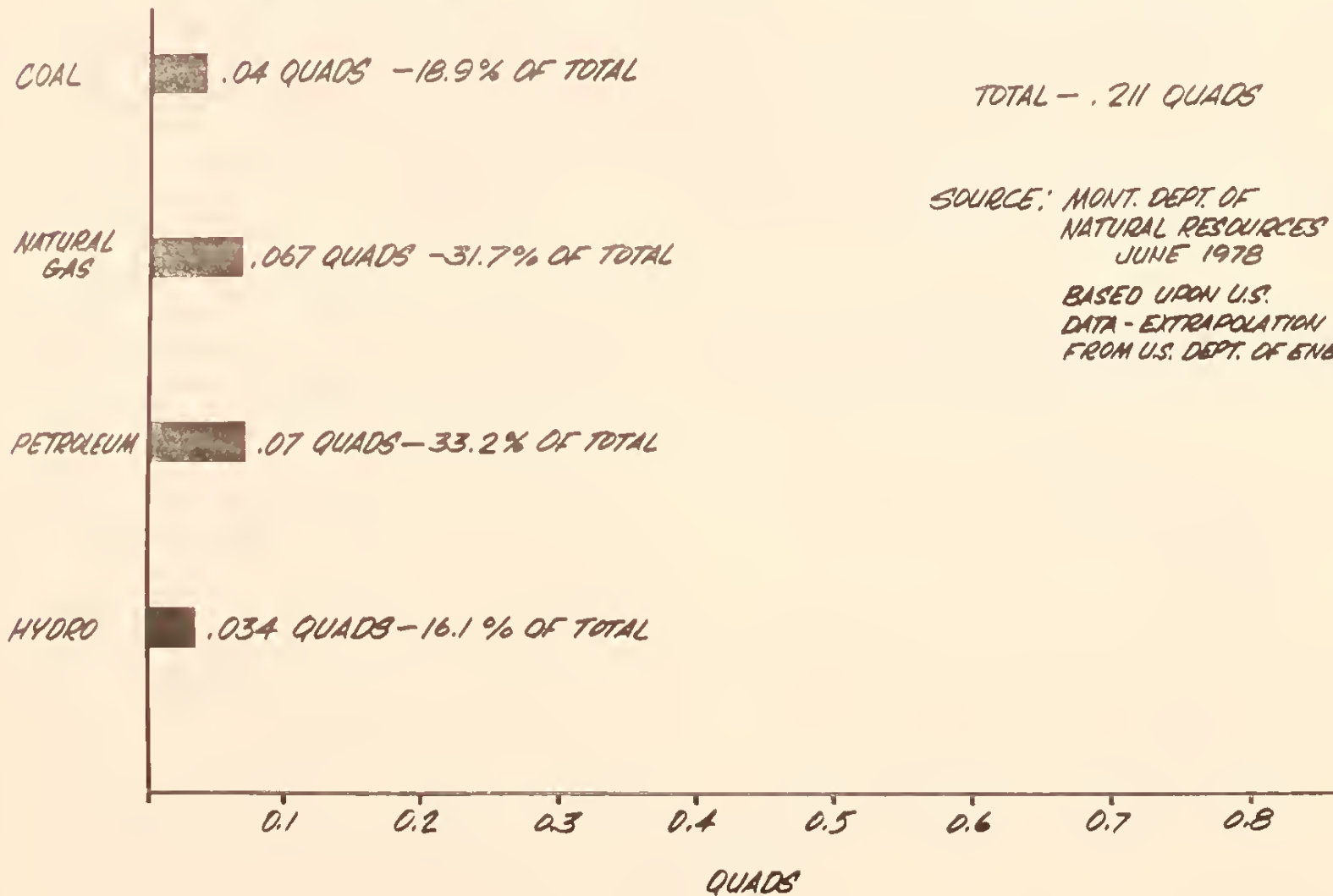
# MONTANA ENERGY CONSUMPTION BY SECTOR 1977

## RESIDENTIAL, COMMERCIAL, INDUSTRIAL AND TRANSPORTATION (QUADS)





# MONTANA ENERGY CONSUMPTION BY PRIMARY ENERGY TYPE 1977 (INCLUDING ELECTRIC UTILITIES) (QUADS)

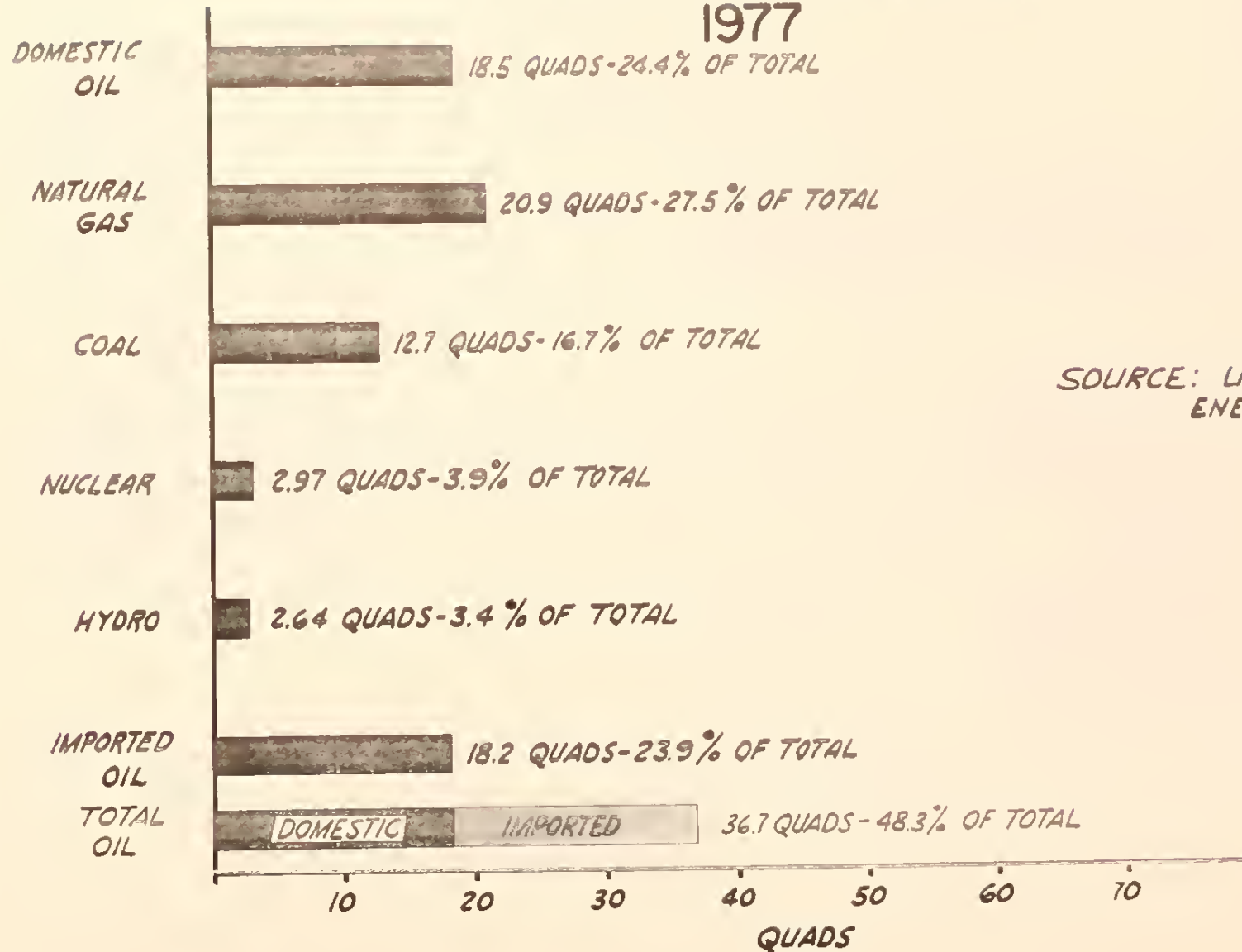


SOURCE: MONT. DEPT. OF  
NATURAL RESOURCES  
JUNE 1978

BASED UPON U.S.  
DATA - EXTRAPOLATION  
FROM U.S. DEPT. OF ENERGY

# U.S. ENERGY PRODUCTION

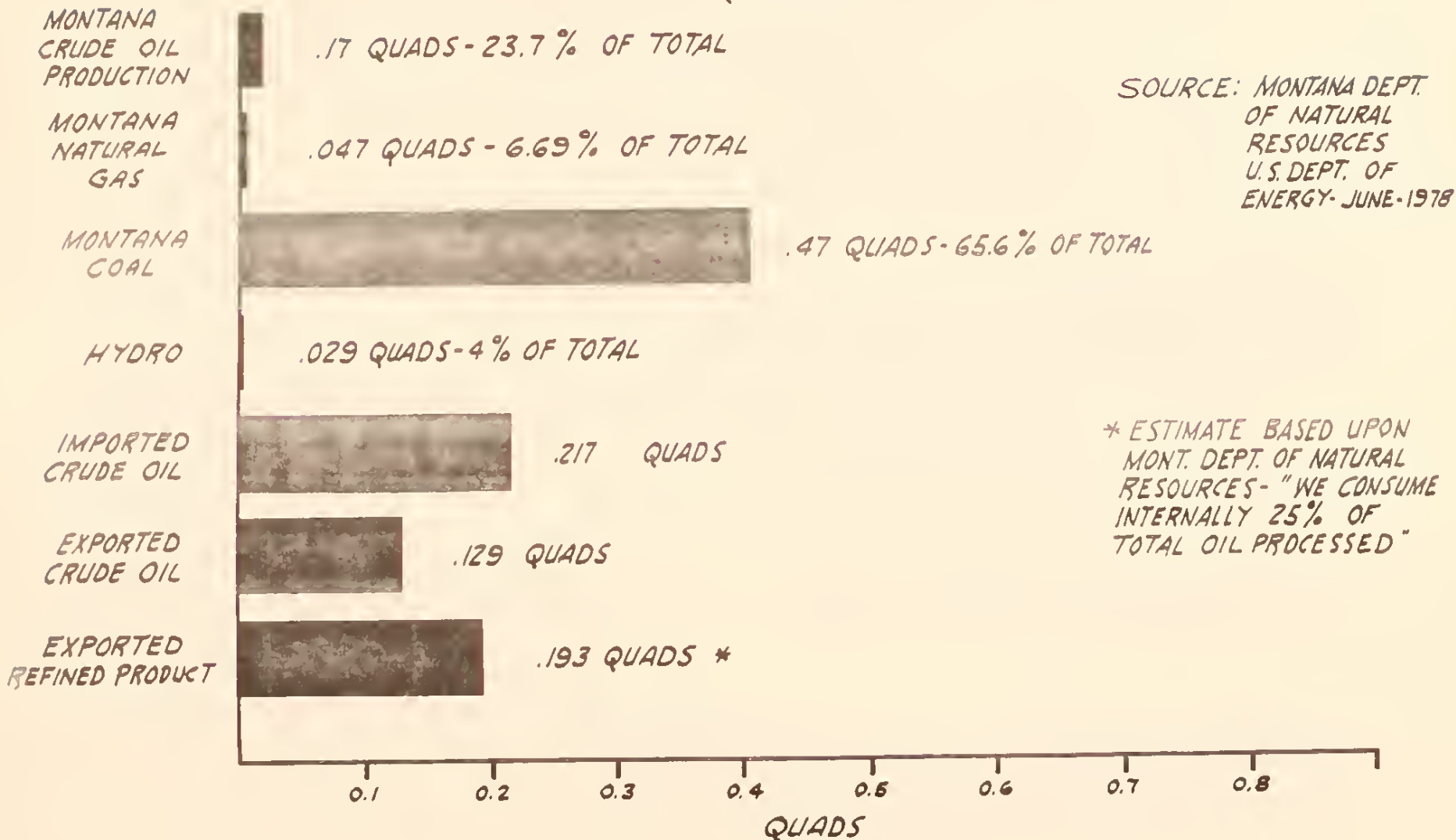
## 1977



SOURCE: U.S. DEPT. OF  
ENERGY, JUNE 1978

# MONTANA ENERGY PRODUCTION BY TYPE OF FUEL

(QUADS)



NATIONAL ACADEMY OF SCIENCE/NATIONAL RESEARCH COUNCIL

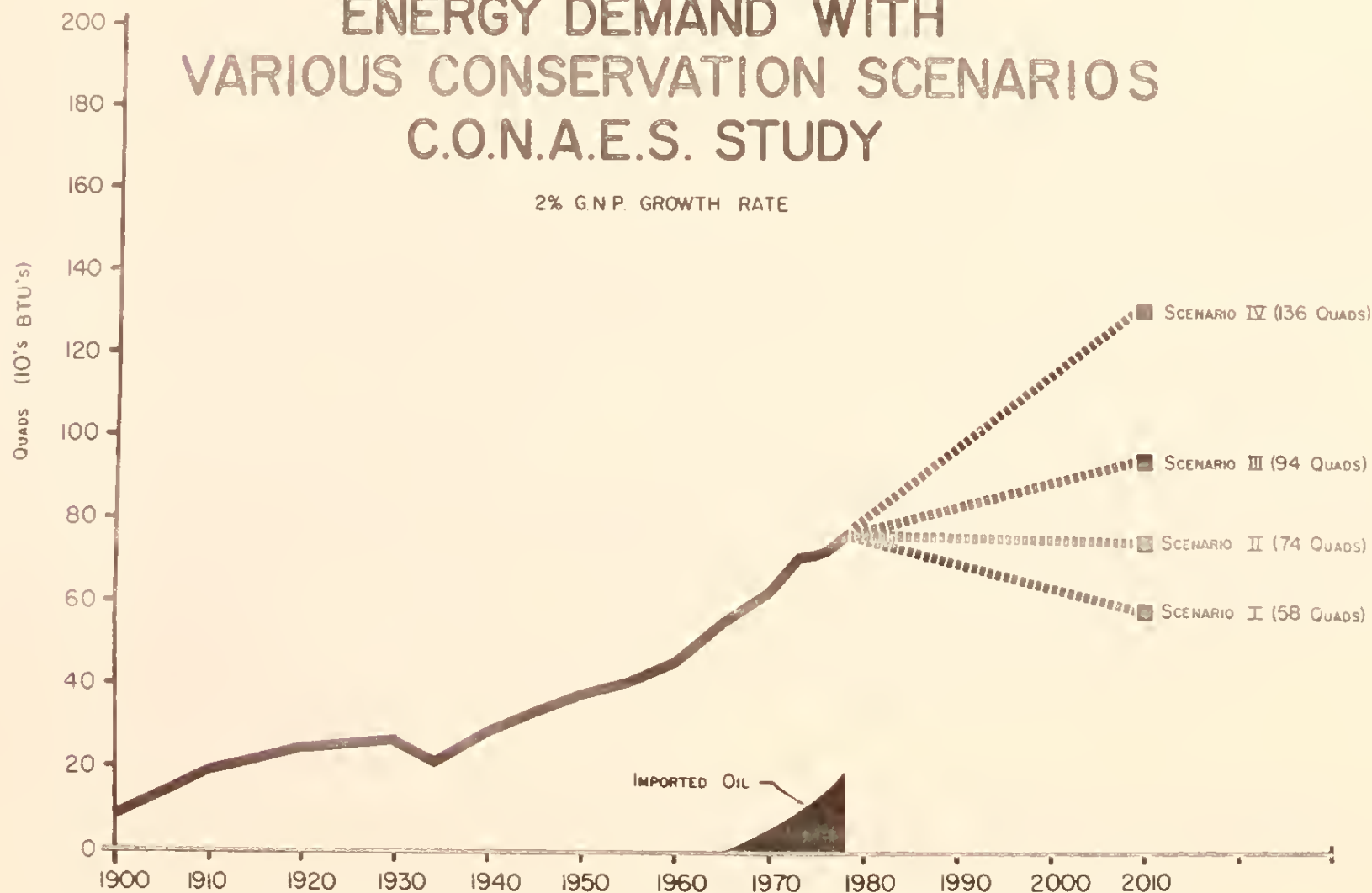
C.O.N.A.E.S.

COMMITTEE ON NUCLEAR AND ALTERNATIVE  
ENERGY SYSTEMS

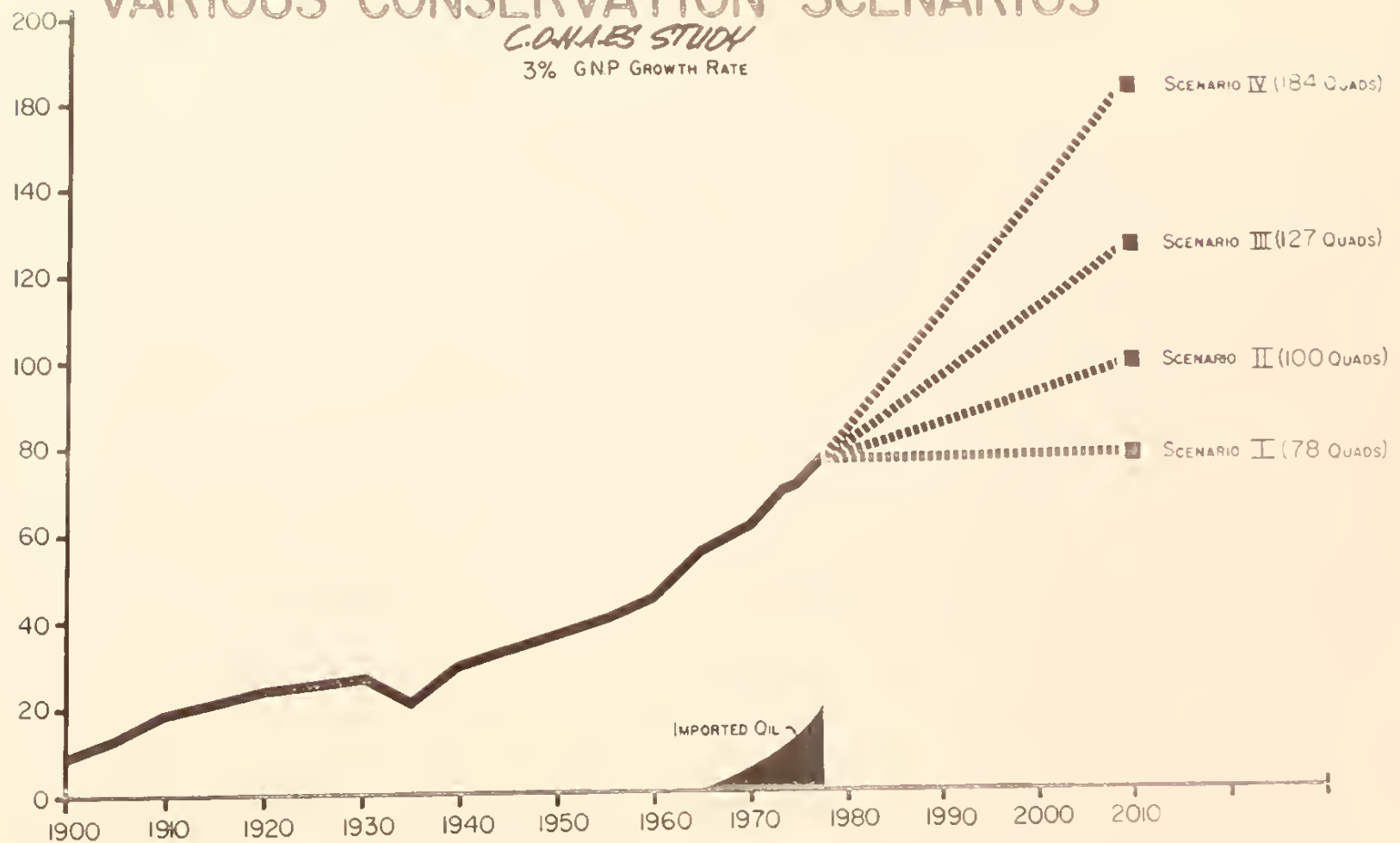
- . National Academy of Sciences/National Research Council
- . Panels
  - . Demand and Conservation
  - . Supply
  - . Environmental Risk
  - . Integrating
- . Grant from U.S. Department of Energy and others
- . Demand and Conservation Panel headed up by Dr. John Gibbons - Environmental Department, University of Tennessee (Apparently to be appointed to TVA by David S. Freeman)

# NATIONAL ACADEMY OF SCIENCE/NATIONAL RESEARCH COUNCIL

## SUMMARY OF TOTAL U.S. ENERGY DEMAND WITH VARIOUS CONSERVATION SCENARIOS C.O.N.A.E.S. STUDY



NATIONAL ACADEMY OF SCIENCE / NATIONAL RESEARCH COUNCIL  
 SUMMARY OF TOTAL U.S.  
 ENERGY DEMAND WITH  
 VARIOUS CONSERVATION SCENARIOS



### SCENARIO I

1. Substantially higher energy prices (4-5 times)
2. Significant life-style accommodations
3. Reduction of energy consumption by equipment to approximately 60% of per capita level today
4. Population shift to warmer climates
5. All activities become energy efficient
6. Goods made more durable
7. More services - less goods
8. Broad shift to rail from truck
9. Maximum practicable co-generation
10. Less energy intensive goods
11. 20% less automobile travel

## SCENARIO II

1. Substantially higher energy prices (4-5 times)
2. New building carefully designed and appliances are much more energy efficient
3. Upgrading existing building thermal integrity
4. Lower thermostats (higher in summer)
5. Aces systems are widely adopted
6. Decentralized use of solar energy for space, air conditioning and water heating (25% new air conditioning, 50% new space heaters, 70% new water heaters in 2010)
7. Passive solar house construction widely adopted
8. Underground and earth covered construction
9. Industry reduces energy consumption per unit output to a value 39% lower than in 1975
10. Throwaway packaging declines - production of chemical foam and fiber glass for insulation increases
11. Industrial co-generation and power plant waste heat utilization become commonplace
12. Transportation shifts from truck to rail
13. Per capita use of mass transit expands nearly fivefold

### SCENARIO III

1. Real energy prices at twice 1975 levels
2. Substantial efficiency increases in buildings
3. Appliance efficiency increase
4. Solar energy becomes more important toward end of period
5. Less growth in aluminum and chemicals' industry
6. Average energy per unit output in 2010 is 26% lower than 1975
7. Industrial co-generation more widely practiced
8. BTU's consumed per auto mile - 1/2 of 1975 value
9. Mass transit 3.5 times larger than 1975

#### SCENARIO IV

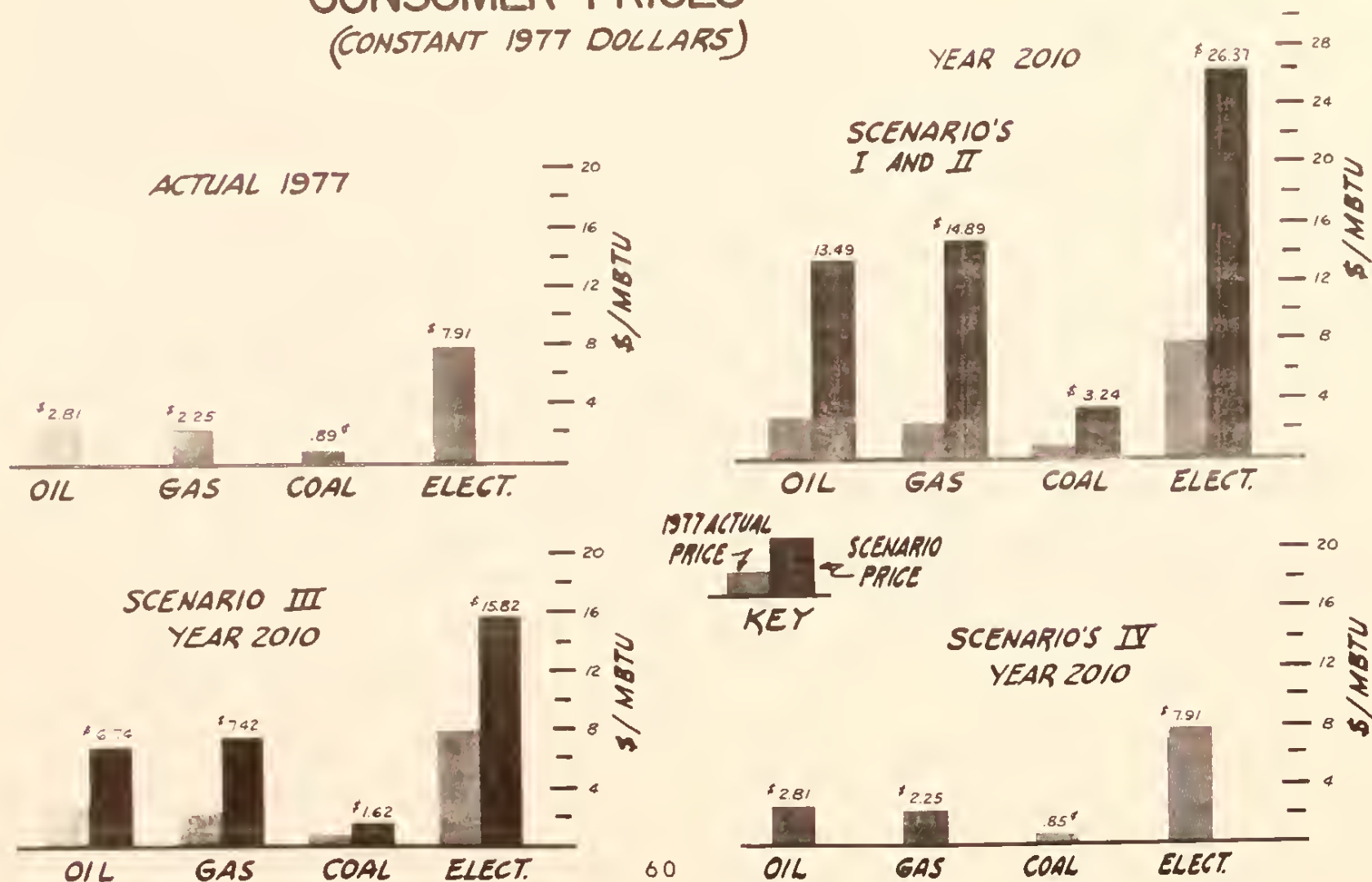
1. Energy prices remain constant in the Scenario (except natural gas which more than doubles by 2010)
2. Efficiency of energy increases modestly over the period
3. Small improvements in gas appliances thru 1990
4. Efficiency improvements occur very slowly
5. Electric space heating continues to be dominated by resistance heaters
6. Energy consumption per unit output drops 18% by the year 2010
7. Current automobile (MPG) policies continue
8. No significant shifts in freight modes
9. Mass transit nearly doubles

# NATIONAL ACADEMY OF SCIENCE / NATIONAL RESEARCH COUNCIL

C.O.N.A.E.S. STUDY

## CONSUMER PRICES

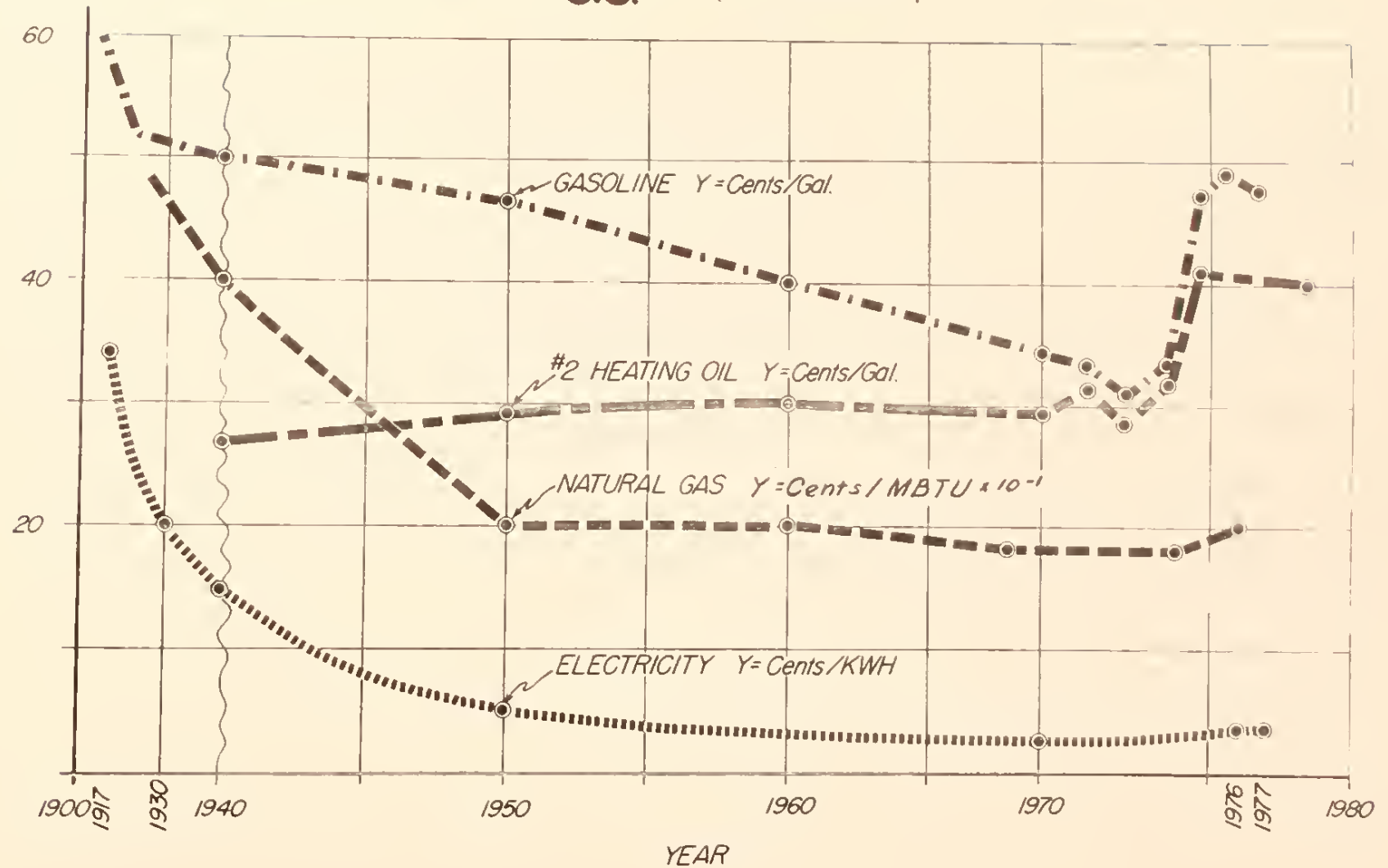
(CONSTANT 1977 DOLLARS)



# HISTORY OF RESIDENTIAL ENERGY PRICES

U.S. (1976 DOLLARS)

CENTS



COMMENTS ON 2% G.N.P. GROWTH RATE

- . RECENT OCCURENCES ON NATIONAL SCENE  
(RECESSION 74-75)
- . POTENTIAL PROBLEMS
  - . SOCIAL & CLASS CONFLICT INCREASES
  - . INTENSE POLITICAL PRESSURE TO  
EXPAND ECONOMY
- . UNEMPLOYMENT MAY BE IN THE 10 TO 20 MILLION RANGE

#### COMMENTS ON SCENARIO I

- . SERIOUS DOUBTS WHETHER POLITICALLY  
POSSIBLE TO IMPOSE IN A FREE DEMOCRACY
- . MAY SIGNAL APPROACH TO LEVEL WHERE  
ENERGY AND G.N.P. BECOME TIGHTLY COUPLED
- . WILL HAVE UTILIZED EVERY ANTICIPATED  
TECHNOLOGICAL IMPROVEMENT TO REDUCE  
ENERGY CONSUMPTION
- . IF WE TRY TO REACH 50% ELECTRICAL SUPPLY  
(28% AT PRESENT)
  - . 2% G.N.P. - 200 NEW 1000 M.W. PLANTS  
OR 6.25 MORE NEW PLANTS/YR.
  - . 3% G.N.P. - 528 NEW 1000 M.W. PLANTS  
OR 16.5 MORE NEW PLANTS/YR.

WE ARE NOW ADDING 17 NEW 1000 M.W. PLANTS/YR.

COMMENTS ON SCENARIO IV

- . HIGH CONSUMPTION OF ENERGY UNSUSTAINABLE  
IN ENERGY DEFICIENT WORLD
- . WORLD OIL PRODUCTION PEAKS IN LATE  
80s OR EARLY 90s
- . REQUIRE TREMENDOUS INCREASE IN NEW PLANT  
SITING AND CONSTRUCTION

RETAINING PRESENT MIX - ELECTRICAL 28%

- . 1712 NEW 1000 M.W. PLANTS BY 2010  
OR 53 PER YEAR

GOING TO 50% ELECTRICAL MIX

- . 3077 NEW 1000 M.W. BY 2010  
OR 96 PER YEAR

NATIONAL ACADEMY OF SCIENCE/NATIONAL RESEARCH COUNCIL

APPARENT POINTS

C.O.N.A.E.S. STUDY

- . LONG TERM TREND OF DECLINING REAL ENERGY PRICES (CORRECTED FOR INFLATION) WAS REVERSED IN THE EARLY 1970s
- . PAST GOVERNMENT POLICIES LED TO ENERGY PRICES FAR BELOW REPLACEMENT COST
- . EVEN UNDER THE MOST AUSTERE OR LOW ENERGY SCENARIOS, ENORMOUS REQUIREMENTS FOR DEVELOPING NEW ENERGY SUPPLIES TO REPLACE DEPLETED RESOURCES ARE NEEDED

- . Significance of the National Academy of Science (C.O.N.A.E.S.) study
- . Points up immense magnitude of the energy supply/demand problem
  - . Potential impact on
    - . Environment
    - . Society
    - . Economy
    - . Quality of Life
- . Points up the very difficult choices/options to be made in our democracy
  - . Need for National Energy Policy
  - . Reduce complexity of decision process
  - . Reduce number of trade-offs
- . Points up need for all involved in the energy picture
 

|                  |                       |
|------------------|-----------------------|
| . Consumers      | . Government agencies |
| . Energy Company | . People              |
| . Commission     |                       |

To be aware and active in reaching these decisions

### IMPLICATIONS FOR FUTURE

- . WE AS INDIVIDUALS
- . WE AS A PEOPLE

WE AS INDIVIDUALS IN A FREE DEMOCRACY

- . DEVELOP PERSONAL COVENANT TO USE ENERGY WISELY AND EFFICIENTLY
- . STUDY ALL ISSUES INVOLVED
- . BECOME ACTIVE AND INVOLVED IN THE ENERGY DECISION MAKING PROCESS
- . INFLUENCE DECISIONS BEING MADE THAT ARE AFFECTING ECONOMIC, SOCIAL AND ENVIRONMENTAL WELL-BEING
- . REJECT THE IMPOSITION OF DECISIONS WITHOUT FULL KNOWLEDGE AND PARTICIPATION IN THAT PROCESS

WE AS A PEOPLE IN A FREE DEMOCRACY

- . AVOID OVERDEPENDENCE ON FOREIGN SOURCES OF ENERGY
- . DEVELOP STRONG CONSERVATION ETHIC
- . MAKE SURE THAT WE HAVE ENOUGH ENERGY SO THAT QUALITY OF LIFE OF ALL CITIZENS CONTINUES TO IMPROVE
- . COSTS OF ENERGY REMAIN TOLEPABLE
- . ENVIRONMENTALLY ACCEPTABLE FUELS BE USED - (ZERO POLLUTION AND ZERO-RISK TO LIFE HAS NEVER EXISTED ON THIS PLANET.)
- BECOME HIGHLY EFFICIENT, GROWING NATION ABLE TO SUPPORT OUR ECONOMIC, ENVIRONMENTAL AND SOCIAL GOALS.



### MONTANA WIND POTENTIAL

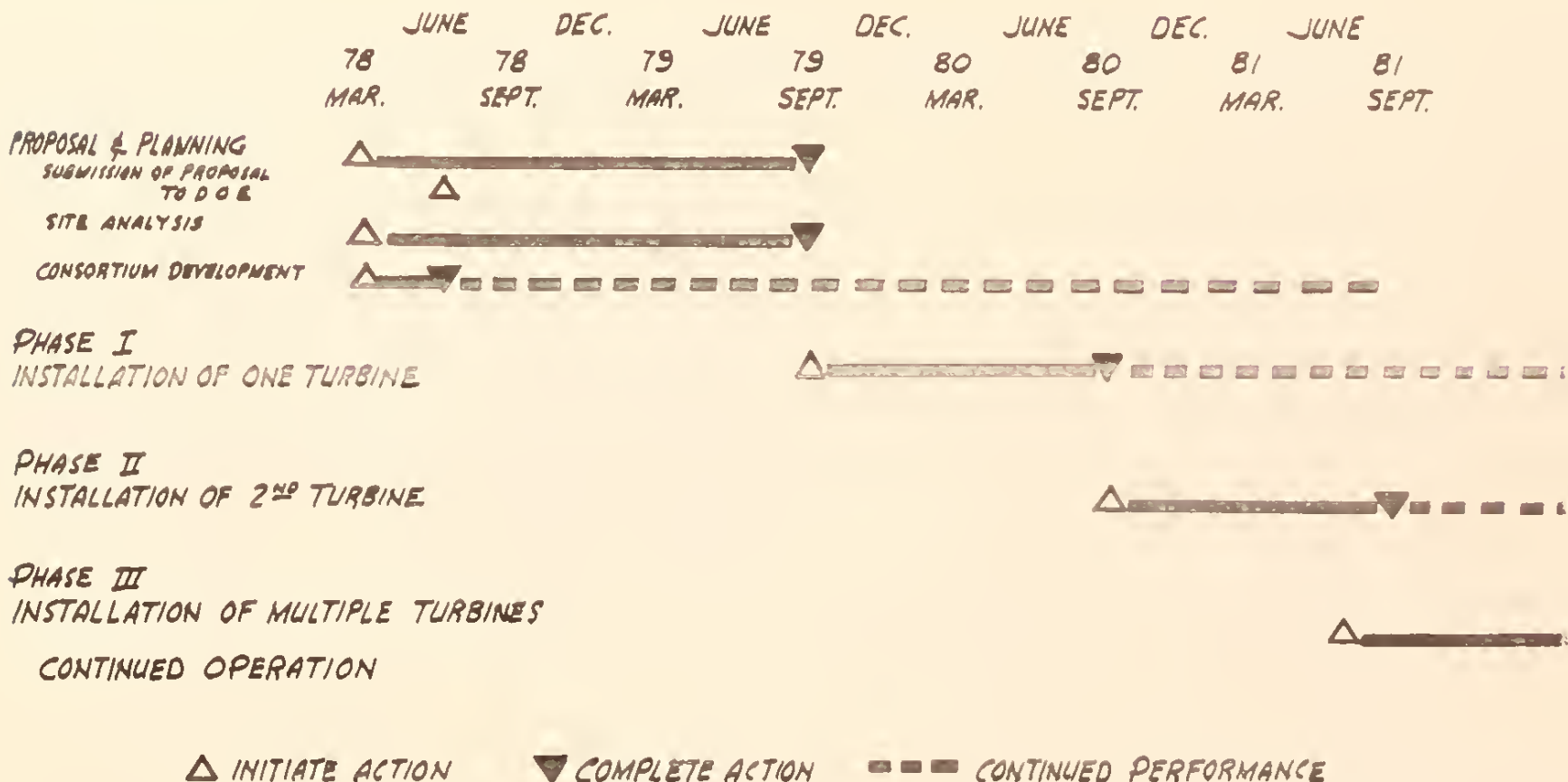
- . POWER AVAILABLE WITHIN 18 MPH CONTOUR  
SURROUNDING THE HIGH GREAT PLAINS  
REGION ESTIMATED TO BE EXTRACTABLE  
MAY BE SEVERAL TIMES PRESENT U.S.  
ELECTRICAL DEMAND
- . LIVINGSTON, MONTANA IS THE SECOND  
BEST SITE IN THE CONTINENTAL U.S.  
FOR HIGHEST AVAILABLE WIND POWER

# 2000 K.W. - 2 M.W. BUREAU OF RECLAMATION MEDICINE BOW PROJECT



M.I.T.C. - M.P.Co. - M.D.U. - BASIN ELECTRIC - M.A.U. - E.P.R.I.  
 LESS THAN 300 K.W.

## DEMONSTRATION DEVELOPMENT SCHEDULE



GLASGOW WIND DEMONSTRATION PROGRAM

### 1.5 K.W. SMALL SCALE MACHINE

#### WIND

#### GREAT FALLS PROJECT

- . A SMALL WIND MACHINE (1500 WATT)  
UNIT HAS BEEN SITED NEAR GREAT FALLS
- . PERFORMANCE EVALUATION TO BE DONE  
DURING COMING YEAR
- . AWAITING RETURN OF INVERTER
- . WORK BEING DONE BY DRAPES ENGINEERING

2000 KW - 2 MEGAWATT

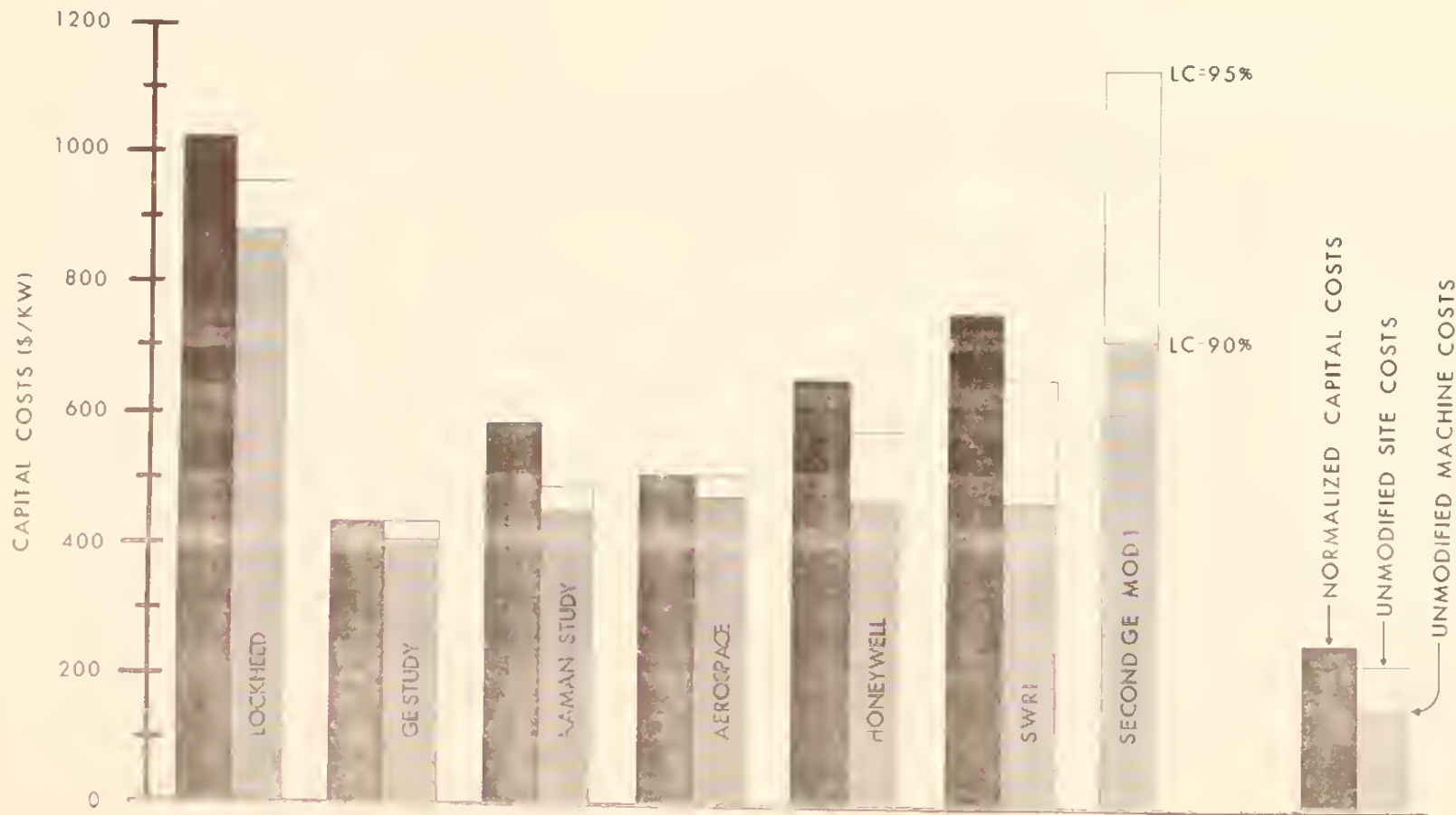
MONTANA POWER - MERDI

LIVINGSTON WIND PROJECT

- . Second best site in U.S. for highest available wind power
- . U.S. Department of Energy R.F.P. - Summer 1978
- . M.O.D. 4 Wind Machine - 2 MW
- . Site evaluation
  - a. State of Montana - Alternative Energy Division
  - b. MERDI
  - c. Montana Power Company
- . Joint sponsorship of proposal for wind machine siting at Livingston - Summer - Fall 1978
- . Acquisition of grant for MOD-4 wind machine siting at Livingston - Fall - Winter 1978

# WIND MACHINE CAPITAL COSTS

JBF SCIENTIFIC

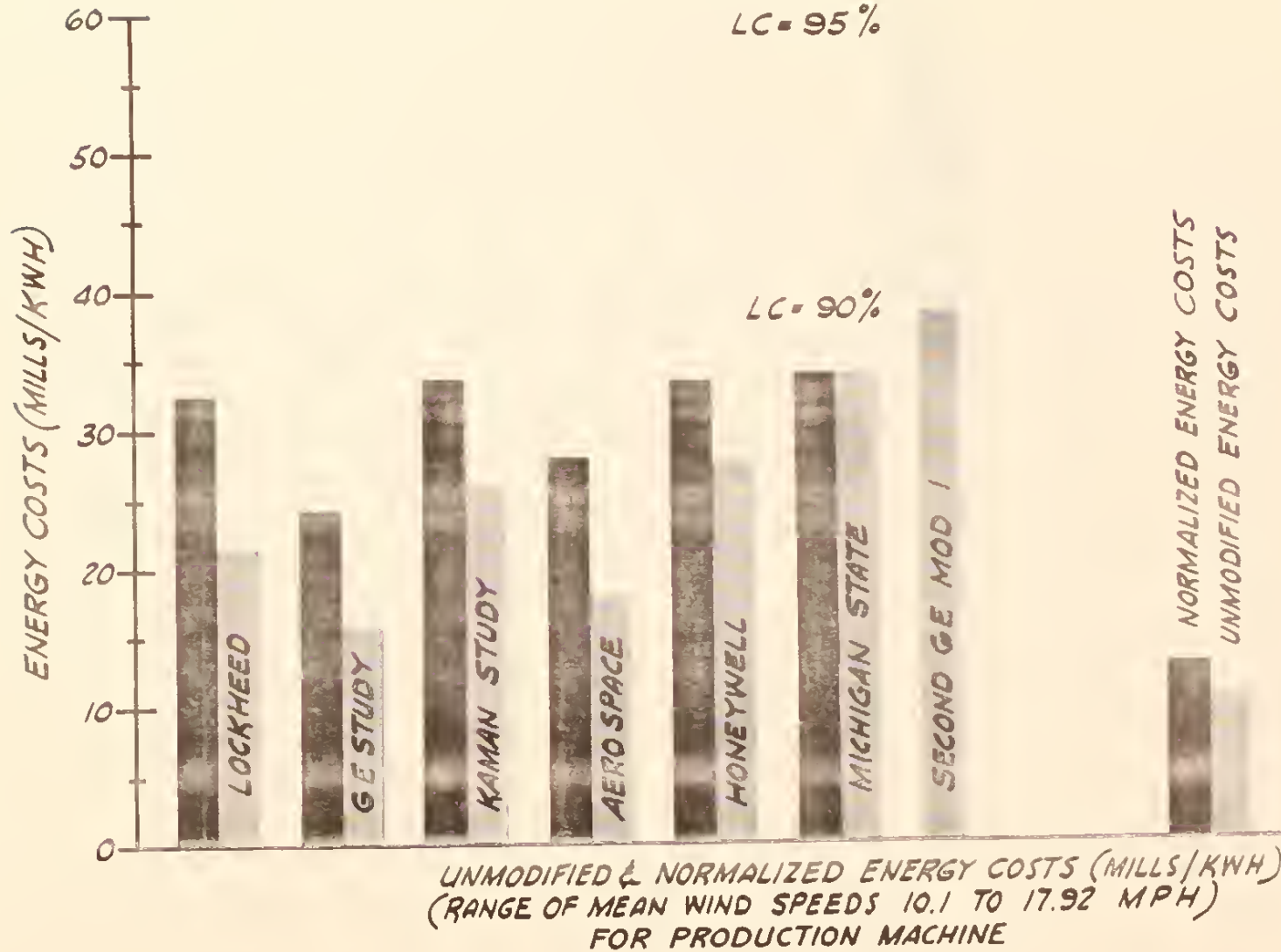


UNMODIFIED AND NORMALIZED WECS CAPITAL COSTS (\$/KW)  
FOR PRODUCTION MACHINE

# PRELIMINARY ESTIMATED WIND ENERGY COSTS

JBF SCIENTIFIC

LC = 95%



### 100 MW WIND FACILITY

- . 110 towers each 200 feet high (20 stories)
- . Each tower has a 220 foot rotor
- . 5,000 acres of land needed
- . Average wind speed must be 24 mph for 100 MW
- . Towers must withstand peak wind speeds of the area  
(Must shutdown or "feather" rotor at 50-60 mph)
- . Six hours of storage needed to meet reliability requirements

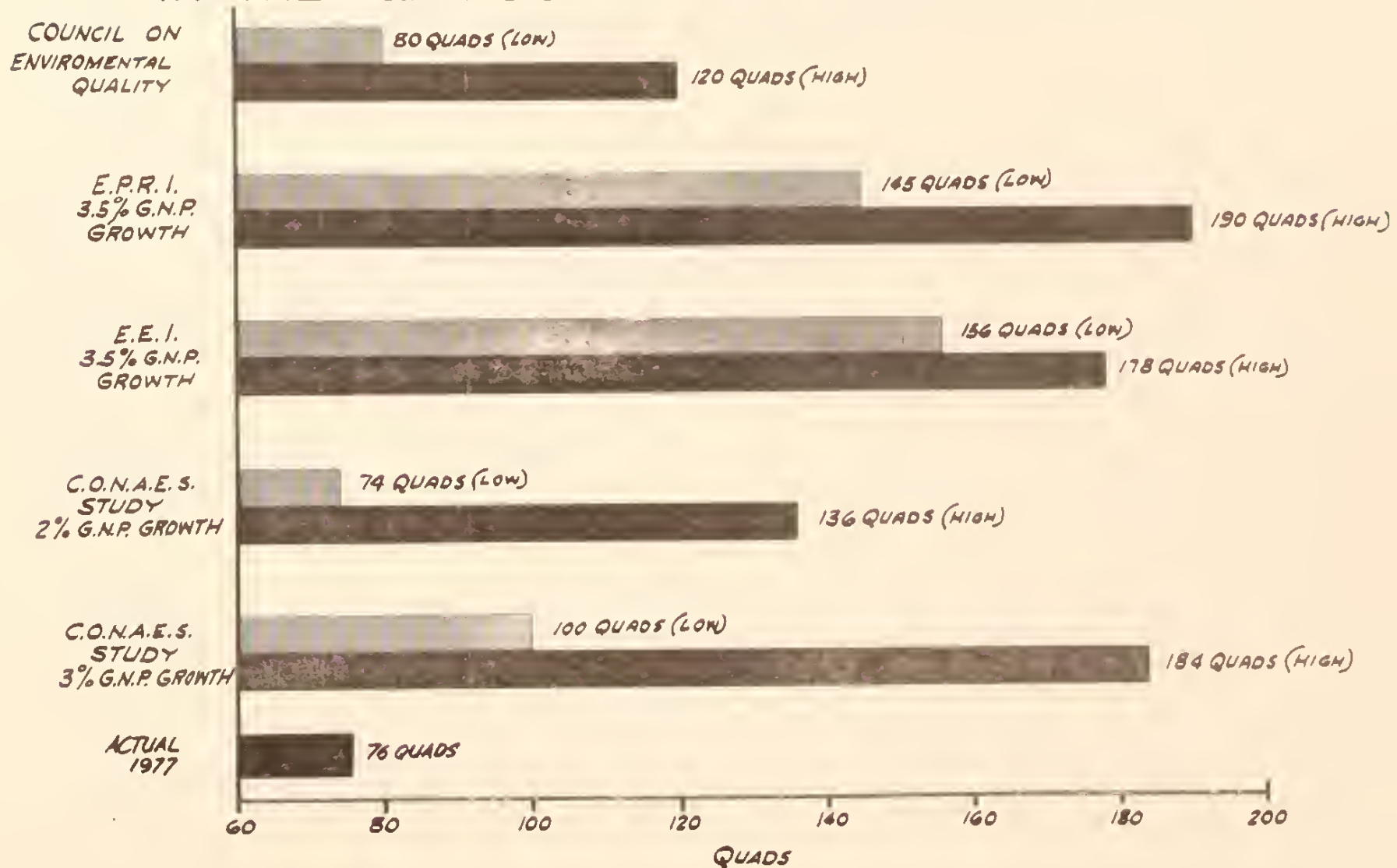
Source: EPRI

#### MONTANA POWER COMPANY WIND POWER PLANS

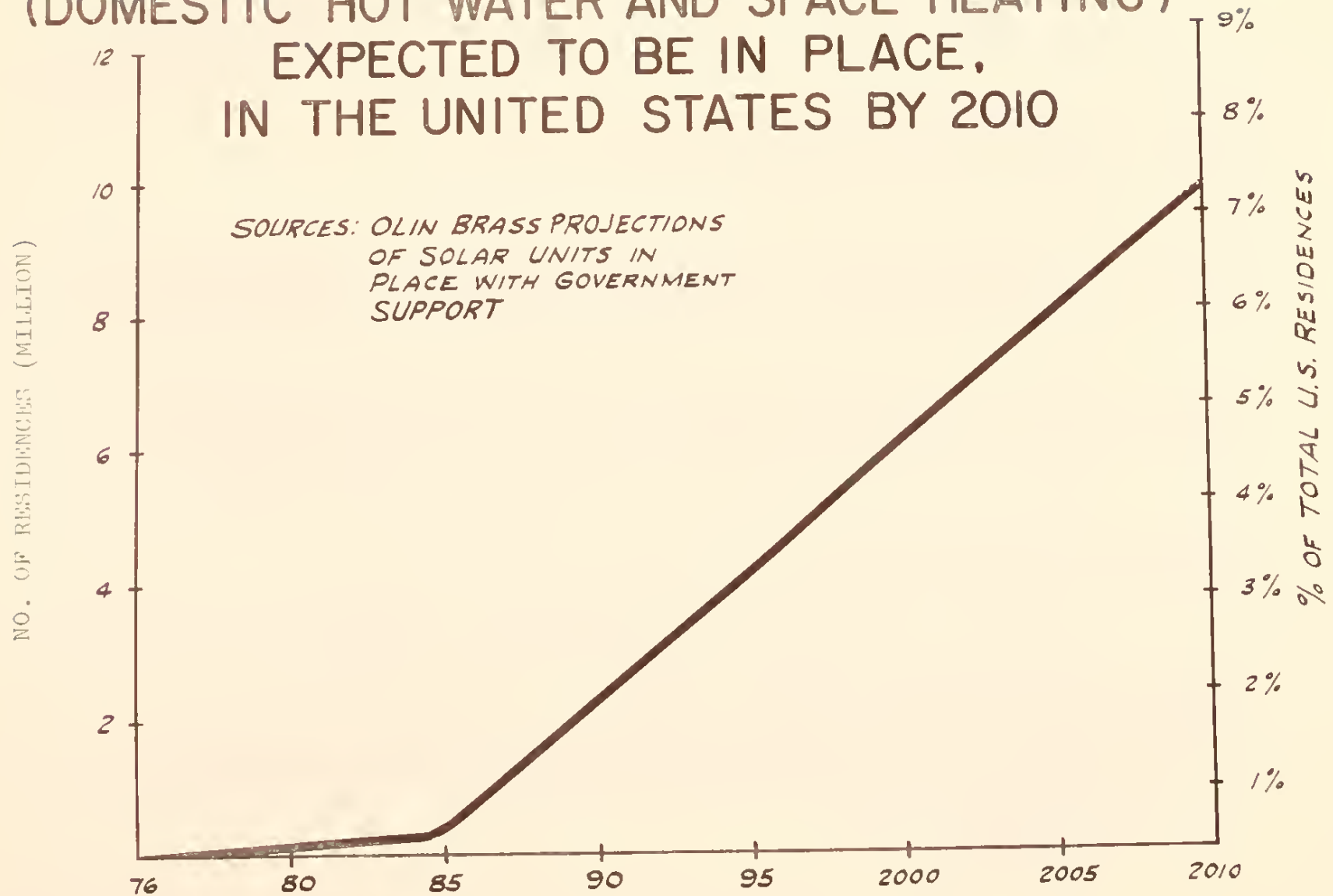
- . MONTANA POWER - GLASGOW PROJECT
- . MONTANA POWER - LIVINGSTON PROJECT
- . CLOSE TRACKING OF MEDICINE BOW PROJECT
- . CONTINUED EXAMINATION OF GREAT FALLS  
WIND PROJECT
- . EXAMINATION OF REVERSING POSSIBILITIES  
WITH SMALL SCALE UNITS SITED IN RURAL  
AREAS
- . DEVELOPMENTAL TECHNOLOGY - TEST RESULTS  
IN EARLY 80's - UPSIDE POTENTIAL YET  
TO BE REALIZED



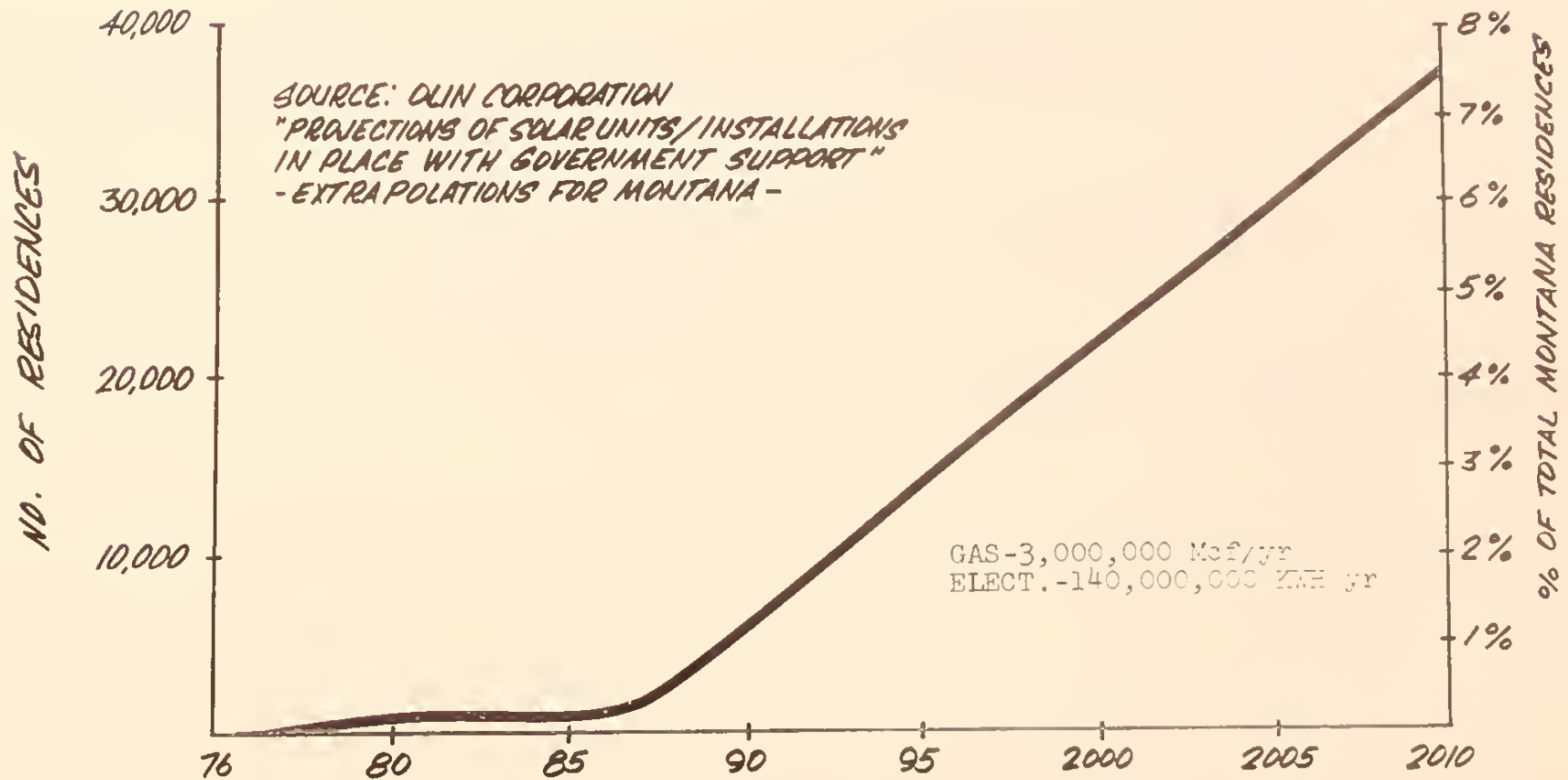
# PROJECTED U.S. ENERGY CONSUMPTION IN THE YEAR 2000 FROM VARIOUS SOURCES



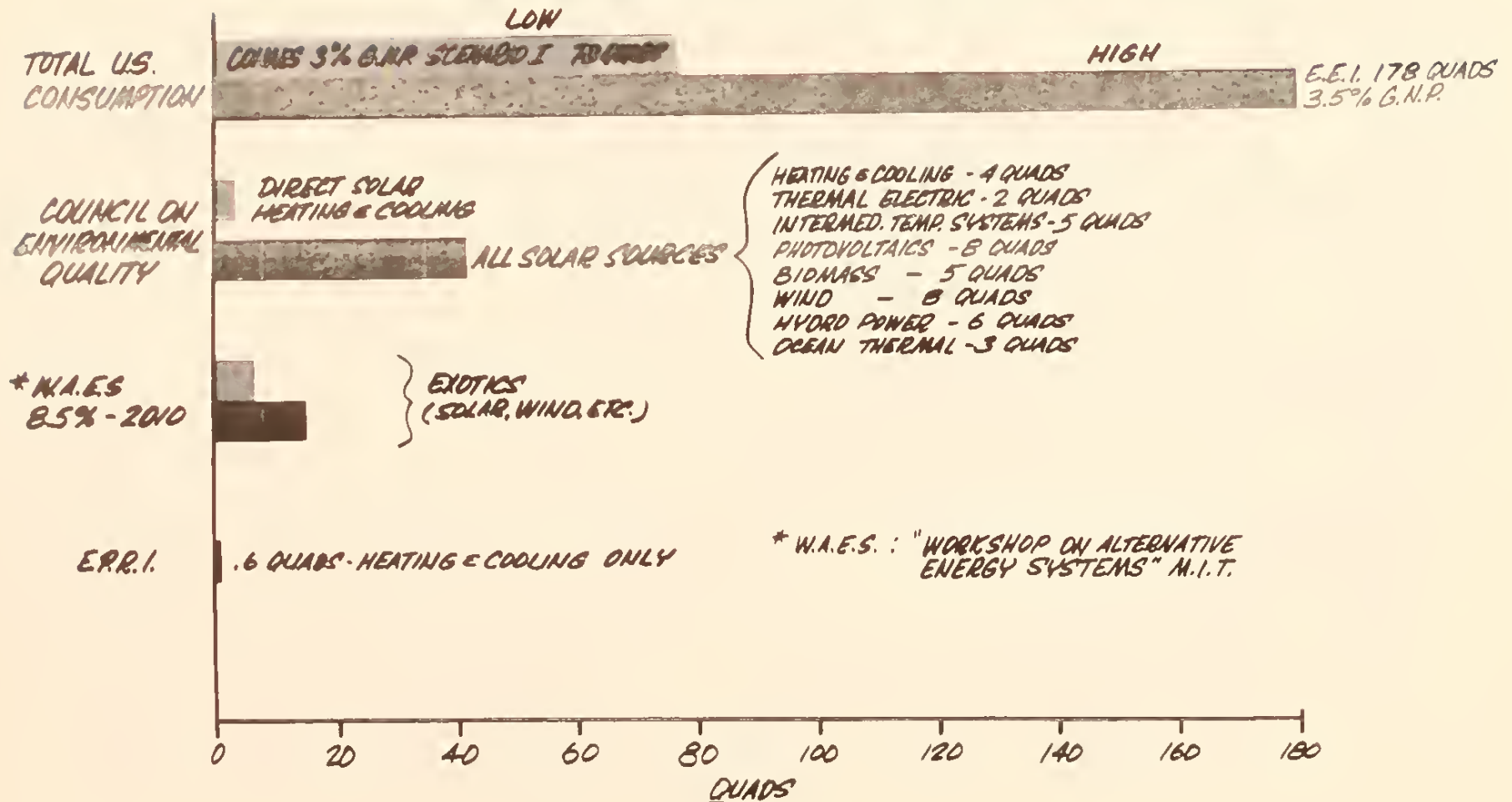
# NUMBER OF SOLAR UNITS (DOMESTIC HOT WATER AND SPACE HEATING) EXPECTED TO BE IN PLACE, IN THE UNITED STATES BY 2010



# NUMBER OF SOLAR UNITS (DOMESTIC HOT WATER AND SPACE HEATING) EXPECTED TO BE IN MONTANA



# SOLAR CONTRIBUTION TO U.S. ENERGY PICTURE FROM VARIOUS SOURCES 2010



MONTANA POWER COMPANY

SOLAR PROJECT

ACTIVE SOLAR SYSTEMS

COLSTRIP

PASSIVE SOLAR SYSTEMS

## SUMMARY

MAGNITUDE OF PROBLEM

CONSERVATION ETHIC

REPLACEMENT OF SHRINKING OIL RESOURCE BASE

ROLE OF ALTERNATIVE ENERGY

SOLAR

WIND

CALL TO ACTION

ELECTRICAL ENERGY SUPPLY



## NEW DIRECTIONS IN ENERGY

### . ELECTRICAL ENERGY SUPPLY IN MONTANA

- . Energy Management Concept and Program
- . Where We Are Now
- . How We Got Where We Are
  - . Planning factors
- . Developing Alternatives
  - . Range of alternatives: steam, nuclear, hydro, combustion turbines, co-generation, solar, wind, geothermal, MHD, other
  - . Role of conservation, effects of alternative energy programs
- . Outlook For The Future
- . Sources of Supply
  - . Basic costs for one "most likely" alternative

## NEW DIRECTIONS IN ENERGY

- . KEY POINT SUMMARY: THE ENERGY MANAGEMENT CONCEPT AND PROGRAM
- 1. Montana Power Company Does Business With Consent of Consumers
- 2. Consumers, Public Service Commission, Montana Power Company Share  
Common Objective
  - . Safe, reliable supply of energy
  - . Reasonable cost
  - . Reasonable profit
  - . As compatible with the environment as possible
- 3. Role of Profitability: Insuring Safe, Reliable Supply in the Future
- 4. Montana Power Company Earns Profitability by Providing to Montanans ...
  - . Economical, reliable, environmentally compatible supply of energy

## NEW DIRECTIONS IN ENERGY

5. We Must Prepare Best Possible Forecasts of Energy Demand
6. We Must Develop Strong Conservation Programs
  - . Basic purpose is to utilize conservation efforts where they are cost effective
  - . Depends upon effective consumer action
    - . One basic purpose:
      - . PUSH FURTHER OUT IN TIME THE NEED FOR NEW GENERATION, TRANSMISSION
      - . CAN MINIMIZE ENERGY COSTS IN ANY TIME PERIOD
7. We Must Explore With the Objective to Develop, as Practical, Supplemental, Renewable, Alternative Energy Resources
  - . Goal is to bring practical, proven benefits to Montanans if, as & when they are developed
  - . Goal is to reduce dependence on foreign oil and to conserve fossil fuel resources

## NEW DIRECTIONS IN ENERGY

### . ENERGY MANAGEMENT PROGRAM -2

8. Concurrently, We Must Provide for Economically/Environmentally Sound Development of Montana's Traditional Resources.
  - . Leads to balanced, reliable, minimum cost environmentally compatible series of alternatives
9. We Must Maintain Flexibility in Our Plans Regarding Potential Alternatives
  - . Continuously review new technology to insure optimal use of practical developing alternatives
  - . Leads to an optimum energy resource plan
10. We Must Optimize Efficient Operation of Existing and Future Resources
  - . Requires advanced control systems
11. We Must Plan and Provide for Sufficient Revenue and Profitability Levels to Insure Safe, Reliable, Economical, Environmentally Compatible Energy Supply.
12. We Must Track, Evaluate and Report Actual Energy and Revenue Results
  - . Review With Public Service Commission

## NEW DIRECTIONS IN ENERGY

### . WHERE WE ARE NOW

#### . Energy Load/Resources Picture

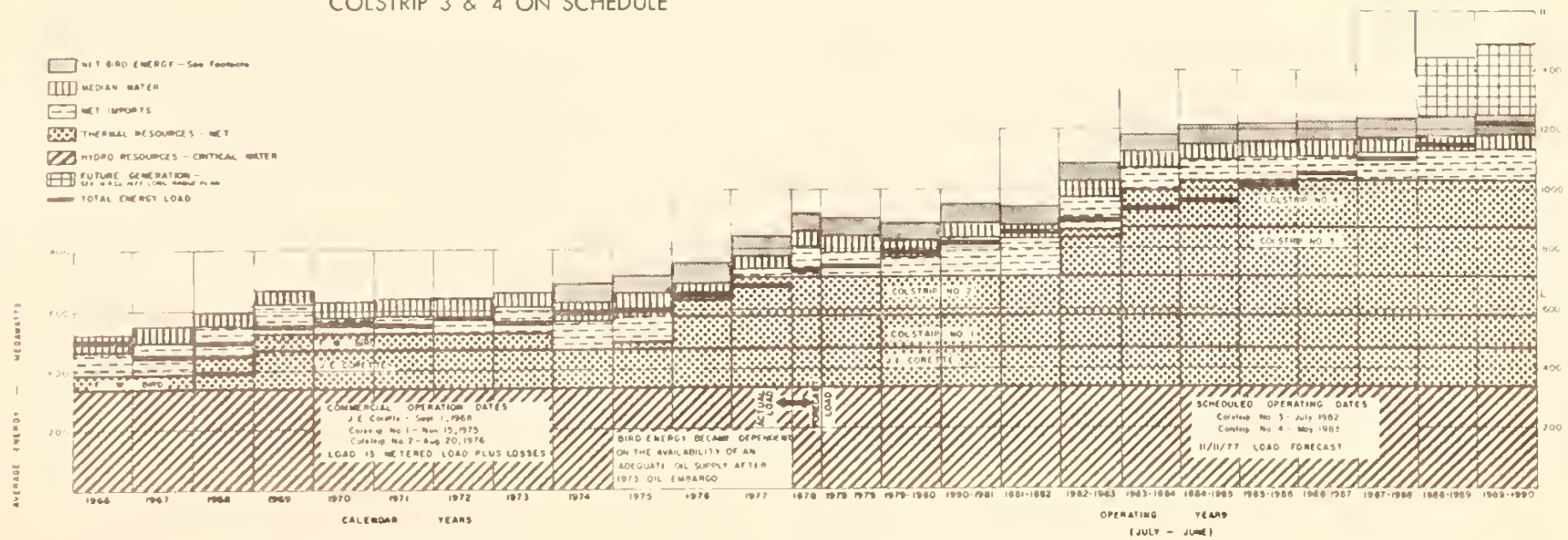
##### . Without Colstrip, very serious picture

##### . Current plan: work out acceptable way to complete the project

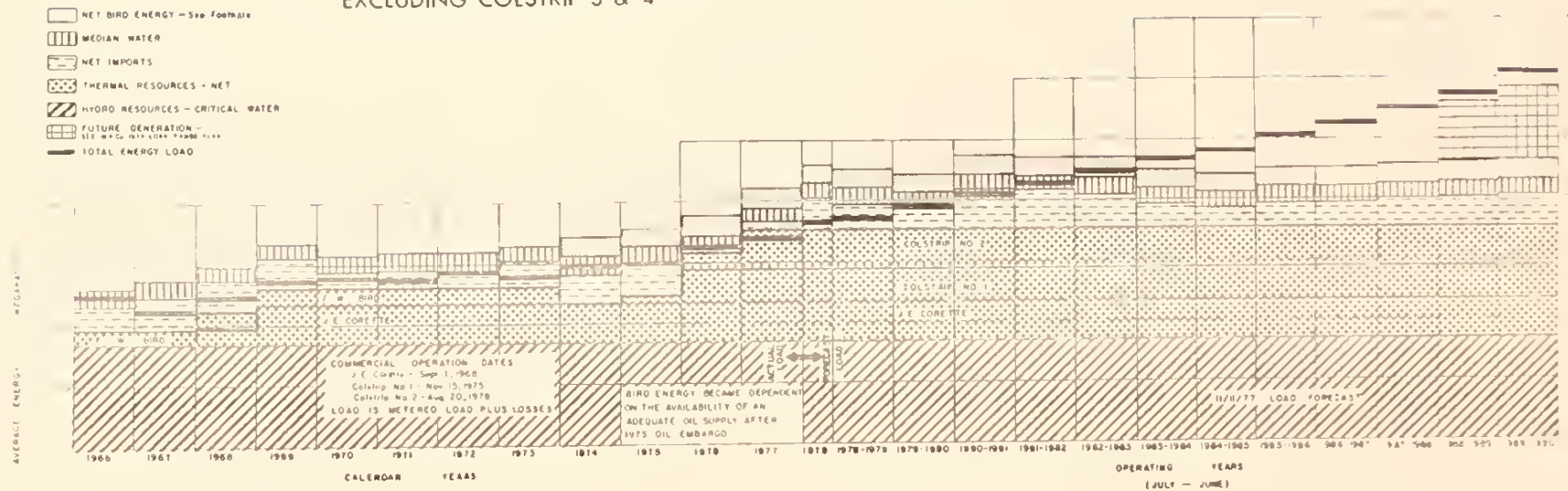
##### . Surplus/Deficiencies under various conditions

##### . Beyond Colstrip #3 and #4

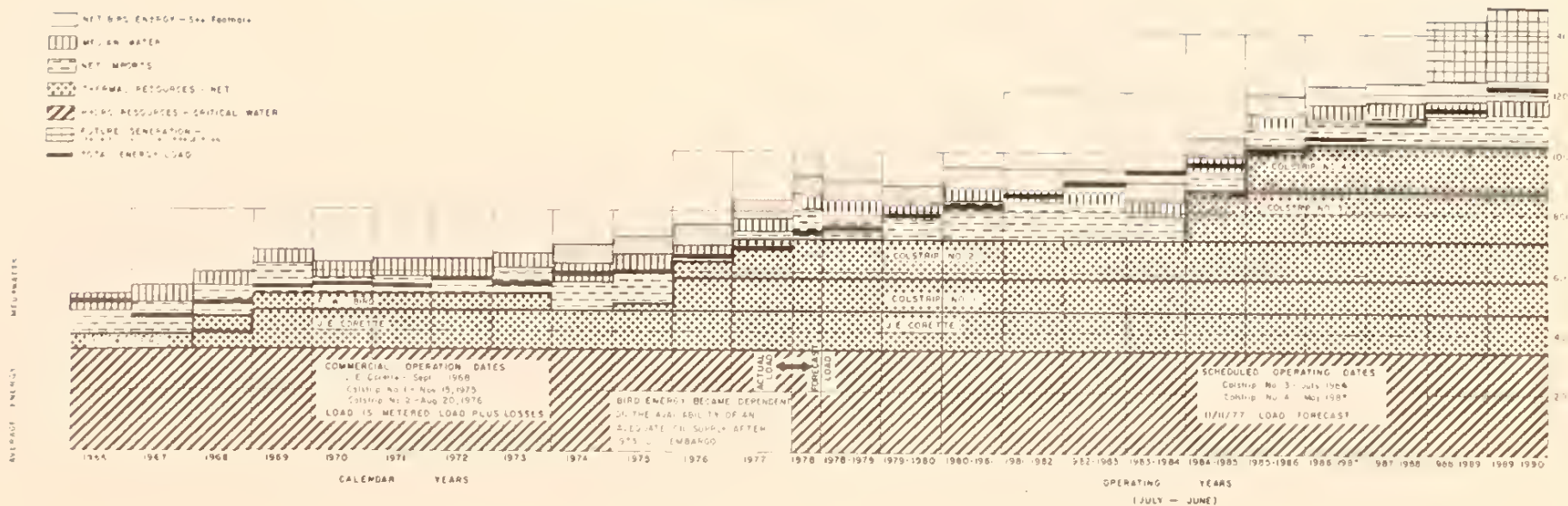
# THE MONTANA POWER COMPANY TOTAL LOADS & RESOURCE CAPABILITIES ANNUAL ENERGY COLSTRIP 3 & 4 ON SCHEDULE



# THE MONTANA POWER COMPANY TOTAL LOADS & RESOURCE CAPABILITIES ANNUAL ENERGY EXCLUDING COLSTRIP 3 & 4

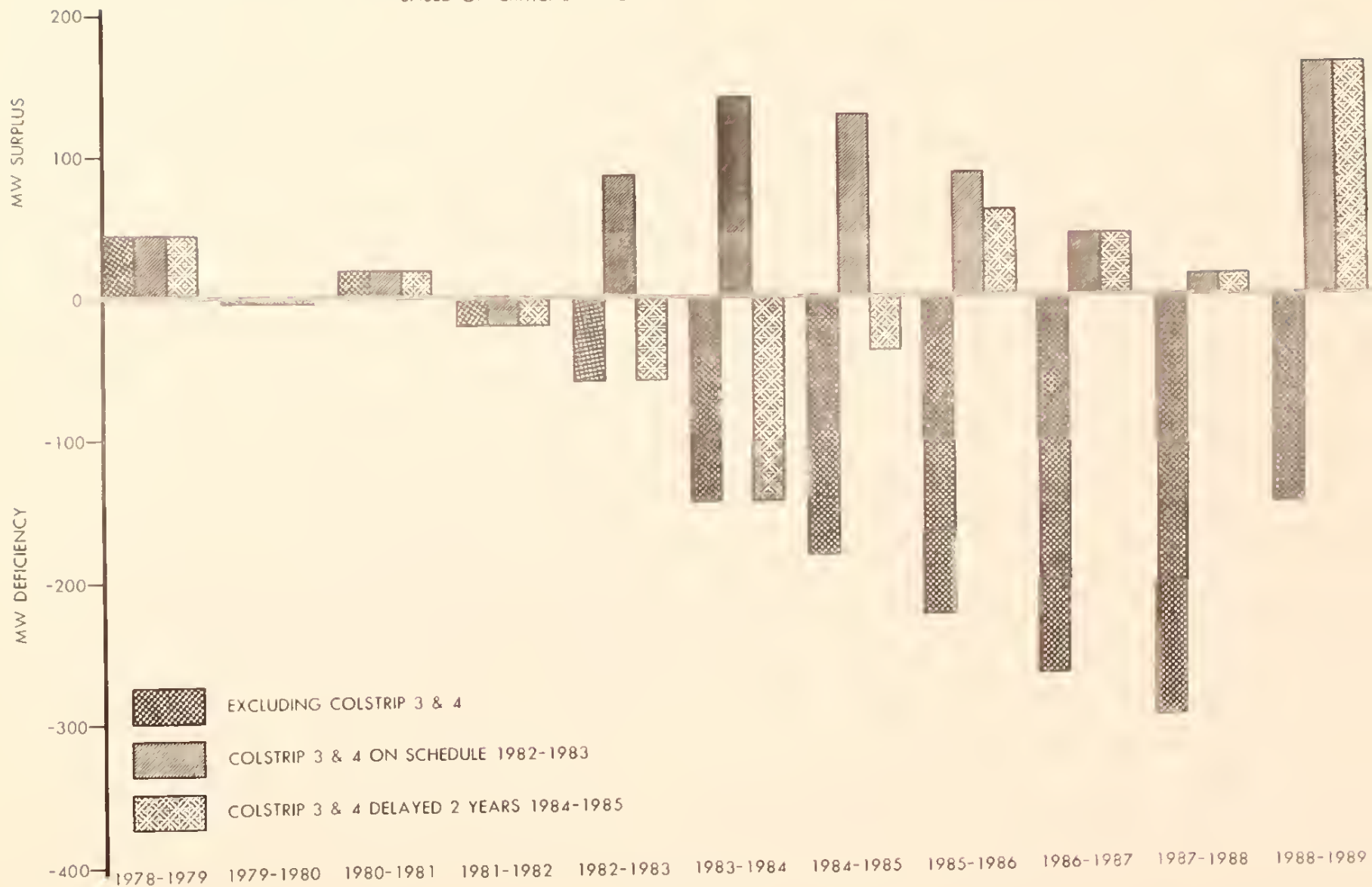


# THE MONTANA POWER COMPANY TOTAL LOADS & RESOURCE CAPABILITIES ANNUAL ENERGY COLSTRIP 3 & 4 DELAYED 2 YEARS



# THE MONTANA POWER COMPANY ANNUAL ENERGY SURPLUS AND DEFICIENCY

BASED ON CRITICAL WATER



## NEW DIRECTIONS IN ENERGY

### . WHERE WE ARE NOW - 2

#### . Montana as a Part of Western United States Energy System

##### . Montana and the Great Northwest

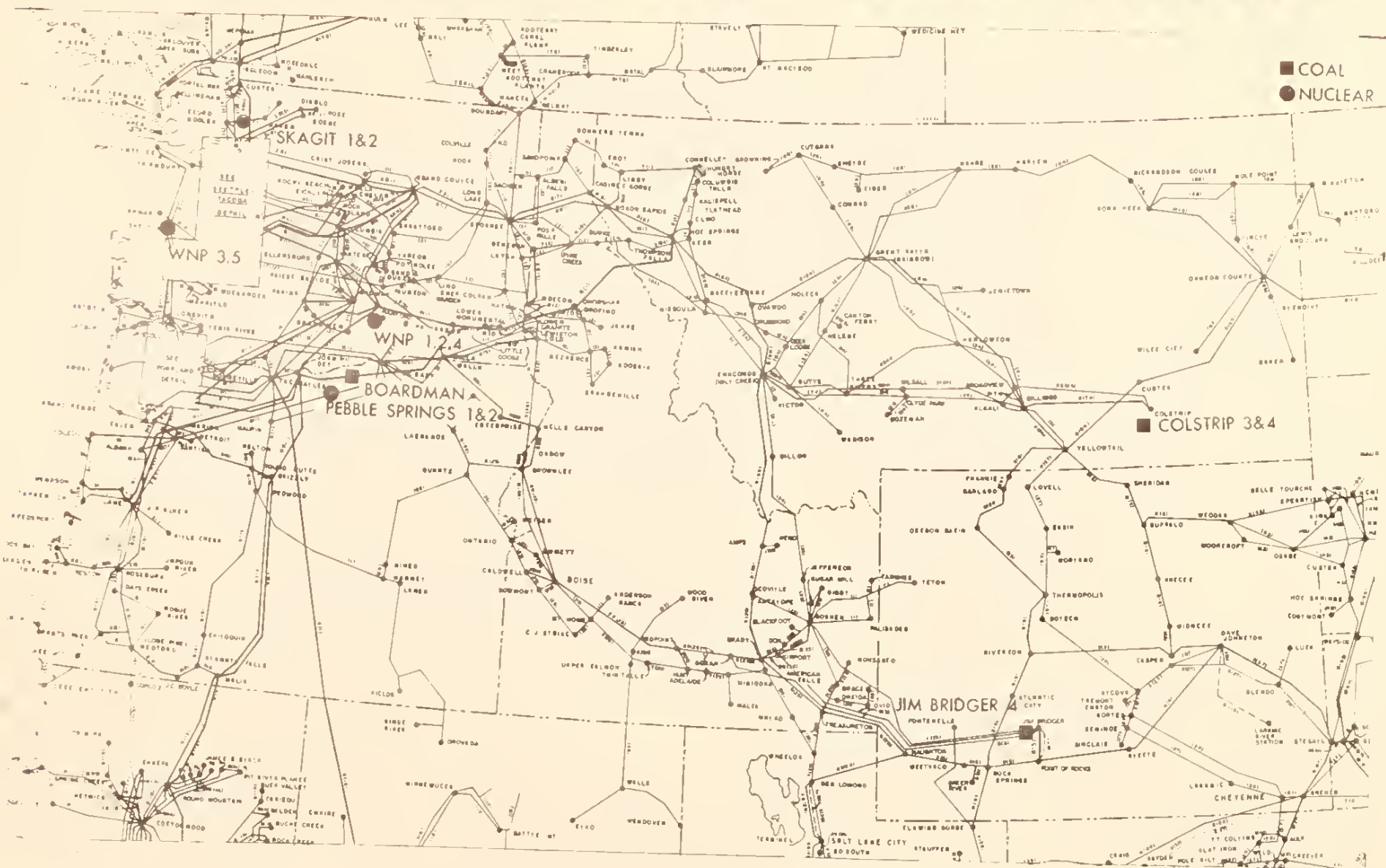
##### . Loads & resources - surpluses & deficiencies

##### . Unlikely we can rely on our neighbors for future supply

# WESTERN SYSTEMS COORDINATING COUNCIL MAP OF PRINCIPAL TRANSMISSION LINES

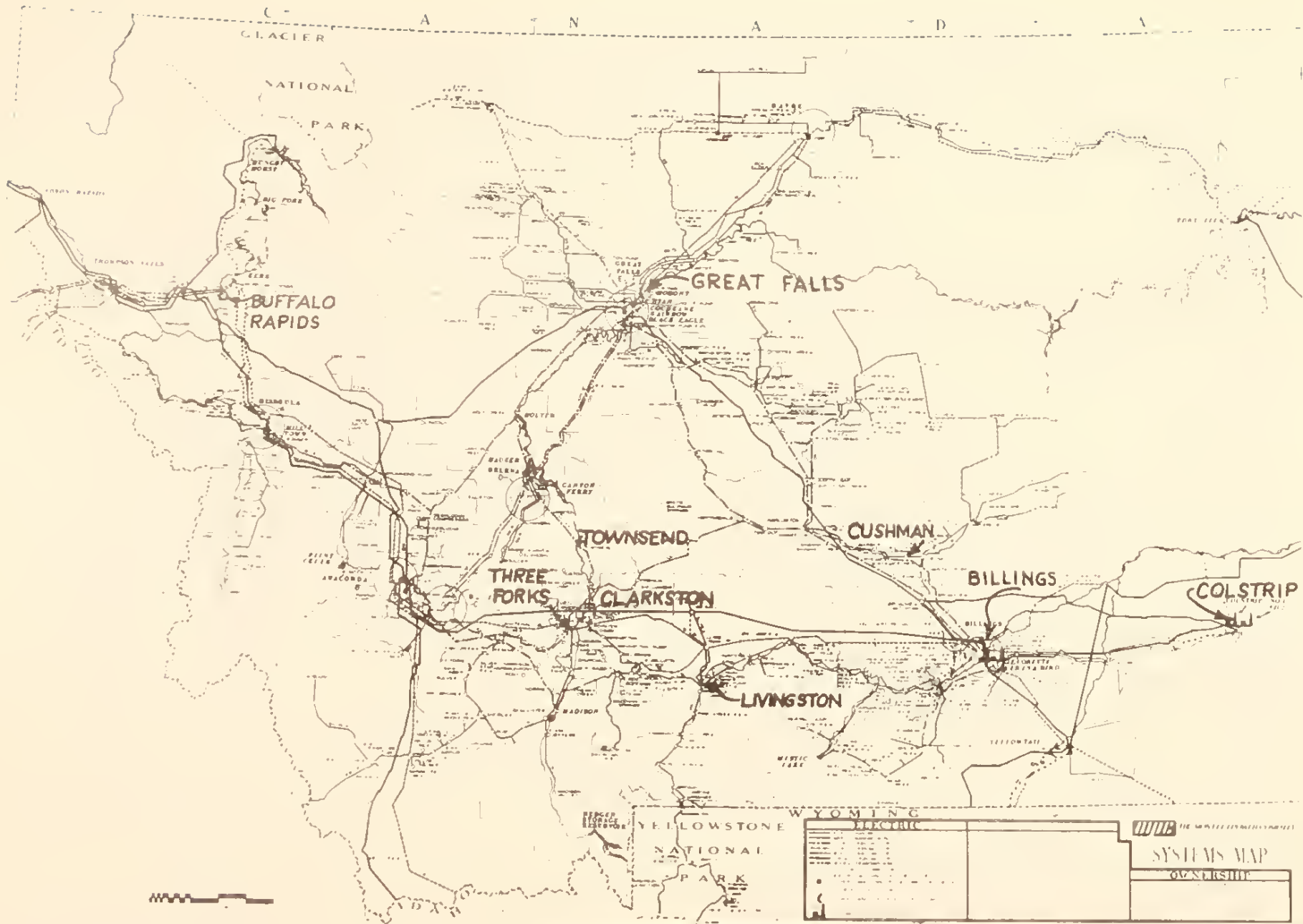


# PACIFIC NORTHWEST POWER SYSTEM WITH PLANTS SCHEDULED ON OUT TO 1990



# THERMAL PLANT SCHEDULES

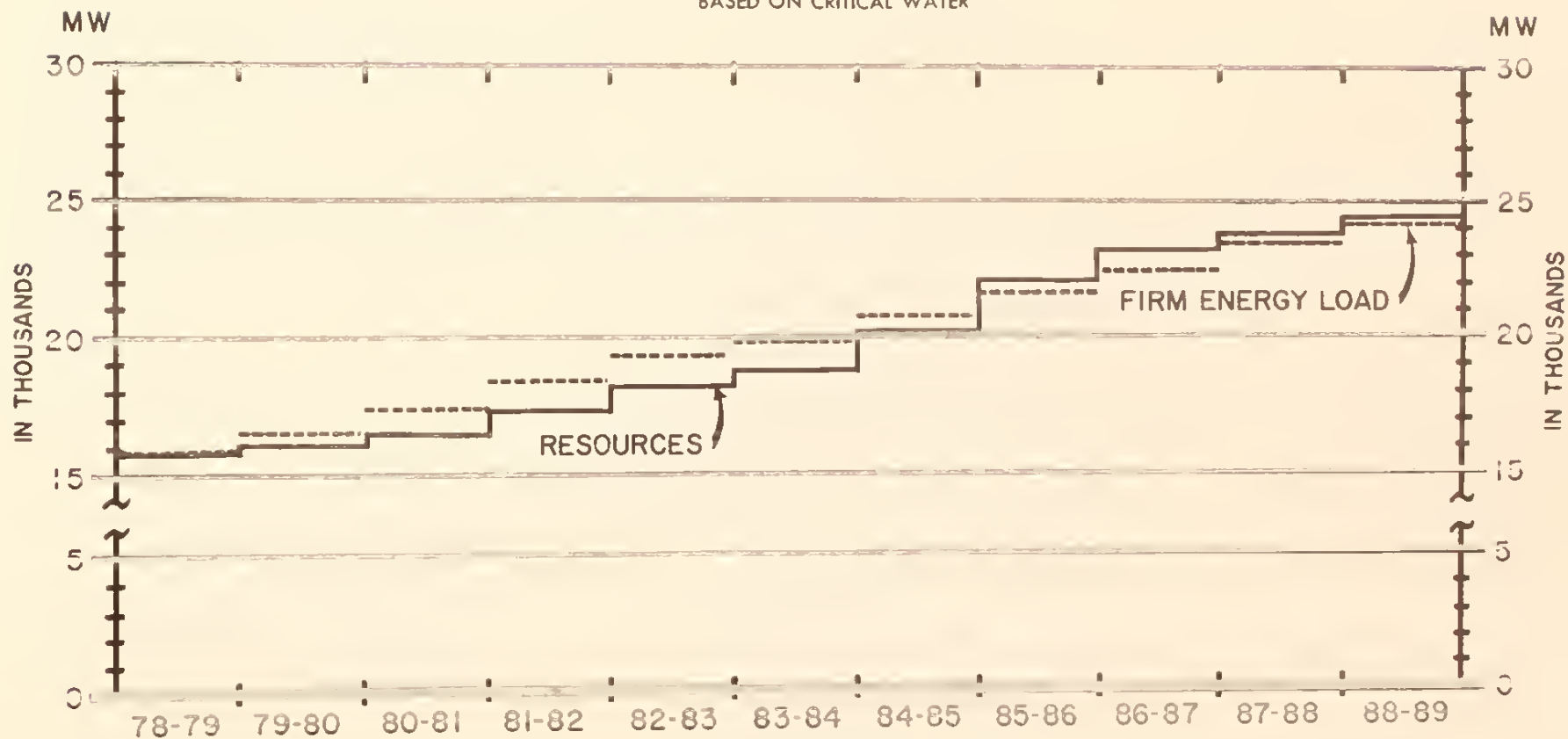
| <u>PLANT</u>      | <u>CAPABILITY<br/>MW</u> | <u>EXPECTED DATE OF<br/>COMMERCIAL OPERATION</u> |
|-------------------|--------------------------|--------------------------------------------------|
| Colstrip #3       | 700                      | July 1982                                        |
| Colstrip #4       | 700                      | May 1983                                         |
| Jim Bridger #4    | 500                      | Dec 1979                                         |
| WNP #2            | 1,100                    | Sept 1980                                        |
| #1                | 1,250                    | Dec 1982                                         |
| #3                | 1,240                    | Jan 1984                                         |
| #4                | 1,250                    | June 1984                                        |
| #5                | 1,240                    | July 1985                                        |
| Pebble Springs #1 | 1,260                    | April 1986                                       |
| #2                | 1,260                    | April 1989                                       |
| Skagit #1         | 1,288                    | July 1985                                        |
| #2                | 1,288                    | July 1987                                        |
| Boardman          | <u>530</u>               | July 1980                                        |
| TOTAL             | 13,606                   |                                                  |



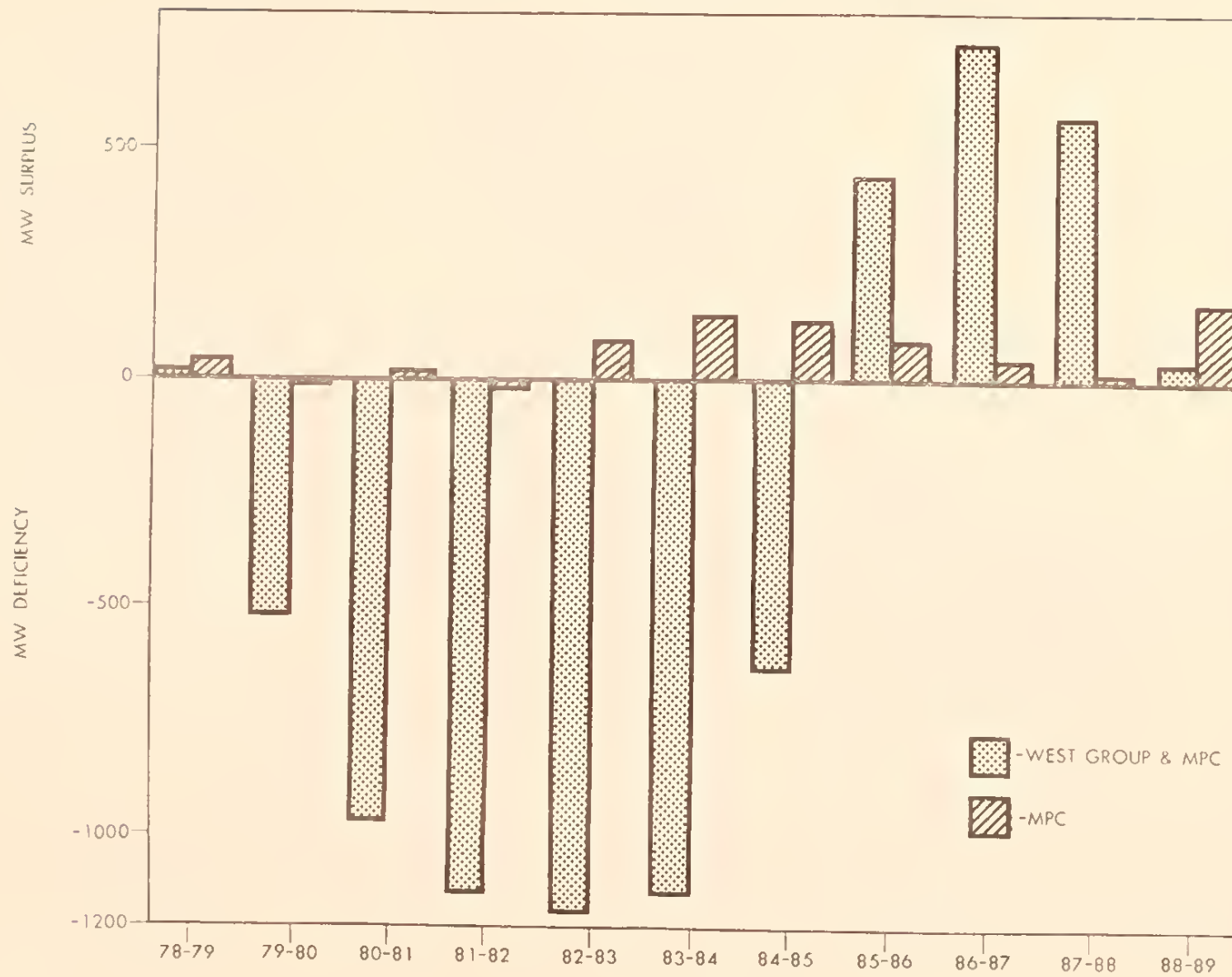
# WEST GROUP AREA + MPC FIRM ENERGY LOADS RESOURCES

COLSTRIP 3&4 ON SCHEDULE 1982-83

BASED ON CRITICAL WATER



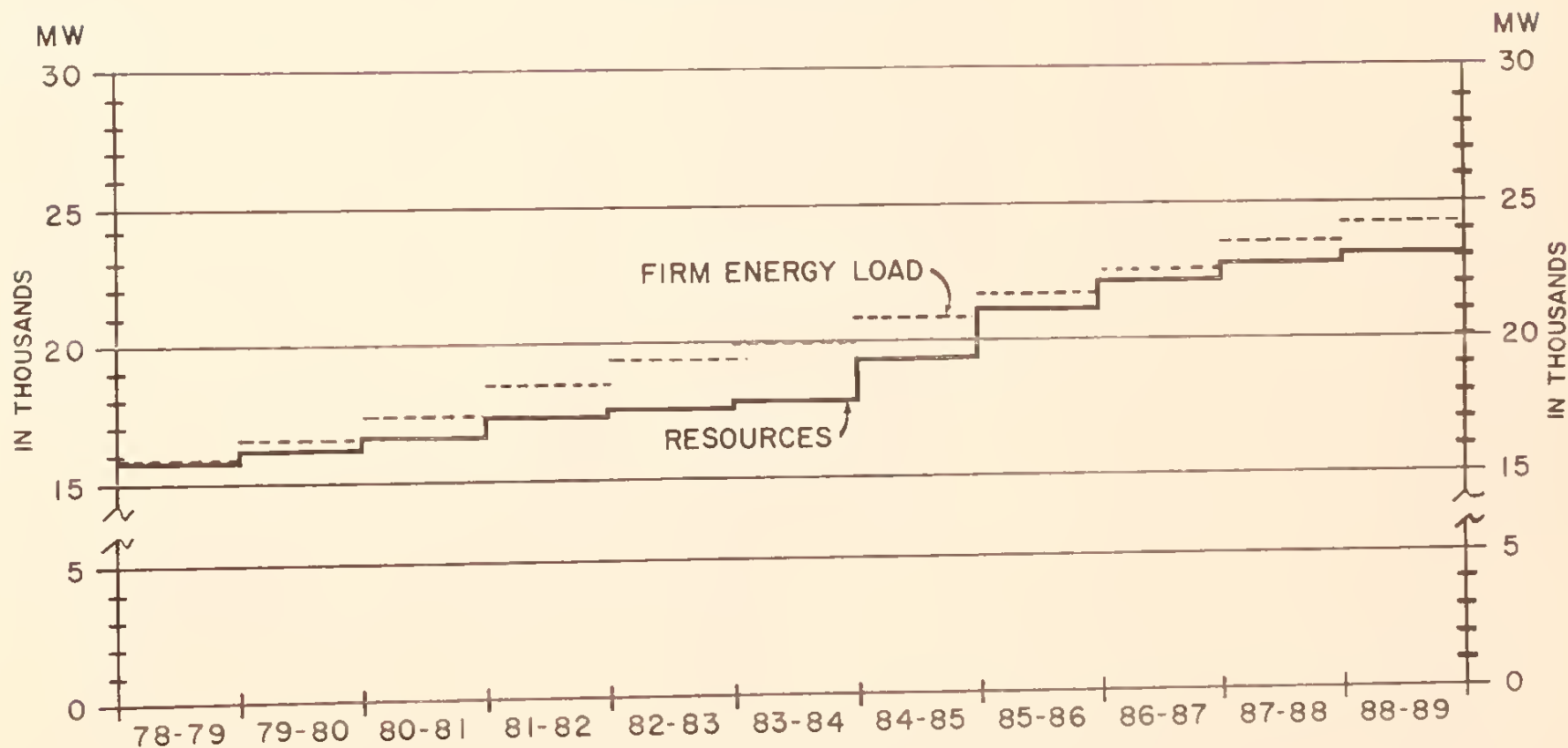
# WEST GROUP & MONTANA POWER CO. ANNUAL ENERGY SURPLUS & DEFICIENCY COLSTRIP 3 & 4 ON SCHEDULE 1982-83



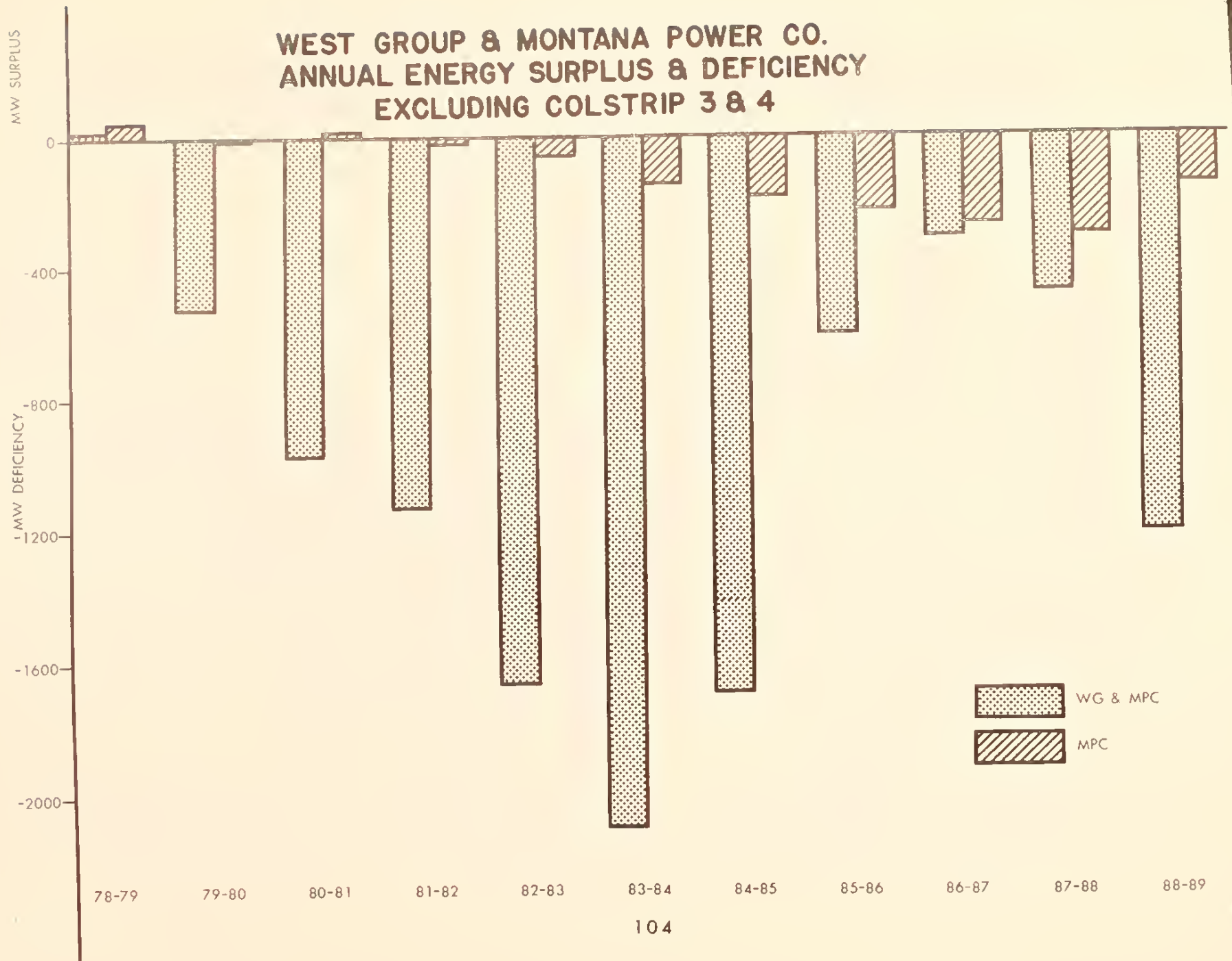
# WEST GROUP AREA + MPC FIRM ENERGY LOADS RESOURCES

EXCLUDING COLSTRIP #3 & #4

BASED ON CRITICAL WATER



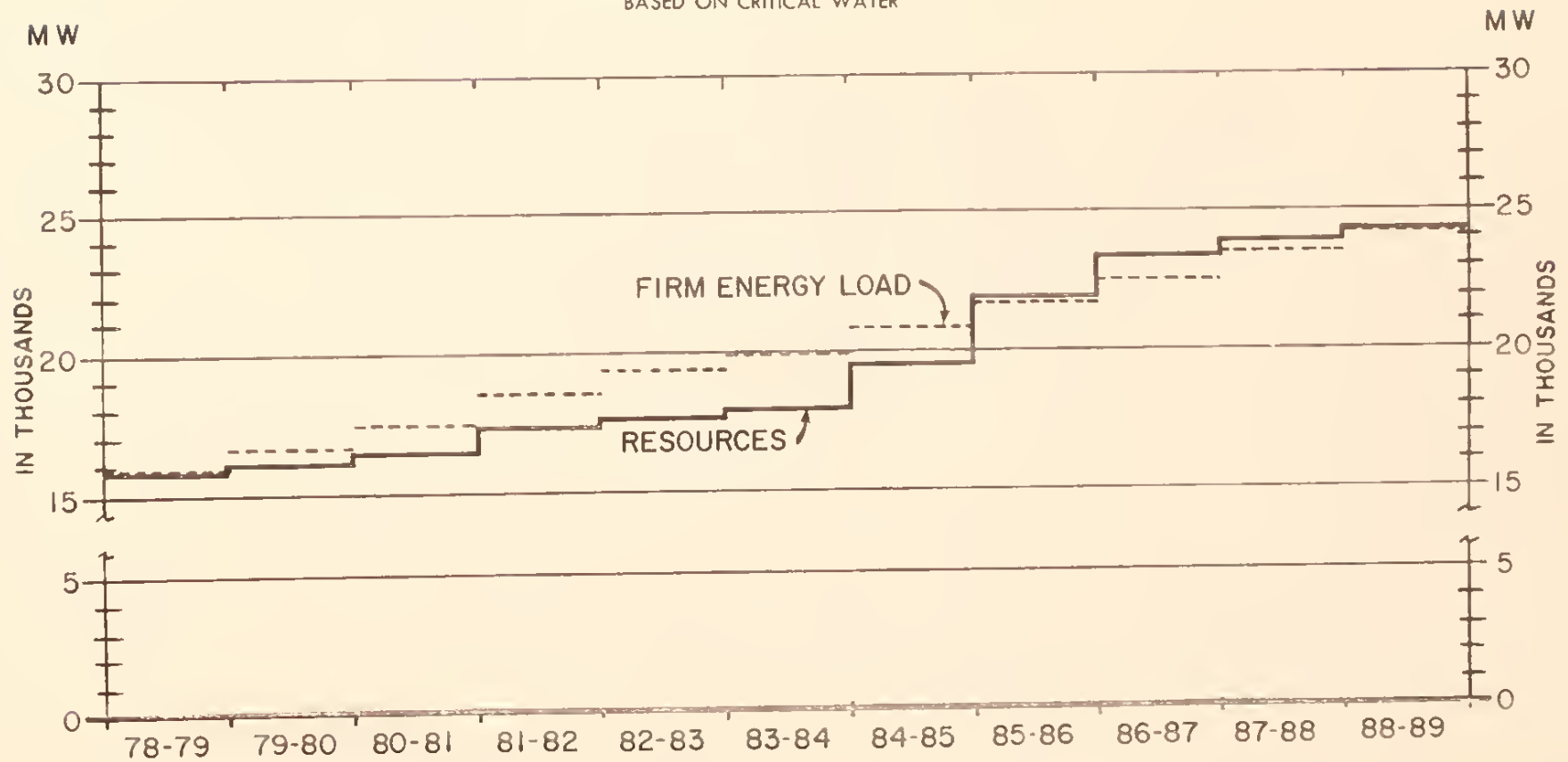
# WEST GROUP & MONTANA POWER CO. ANNUAL ENERGY SURPLUS & DEFICIENCY EXCLUDING COLSTRIP 3 & 4



# WEST GROUP AREA + MPC FIRM ENERGY LOADS RESOURCES

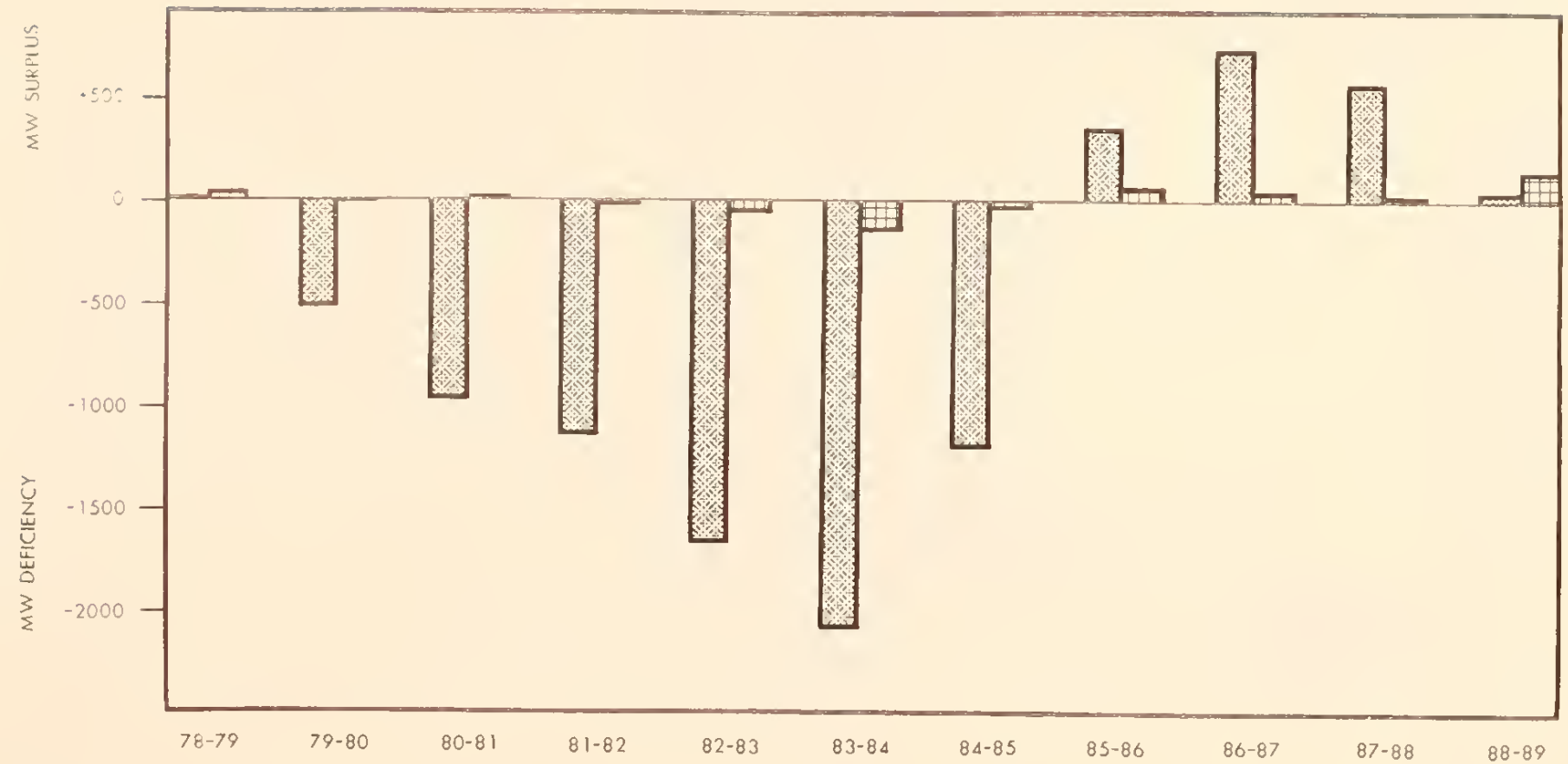
COLSTRIP 3&4 DELAYED 2 YEARS 1984-85

BASED ON CRITICAL WATER



# WEST GROUP & MONTANA POWER CO. ANNUAL ENERGY SURPLUS & DEFICIENCY

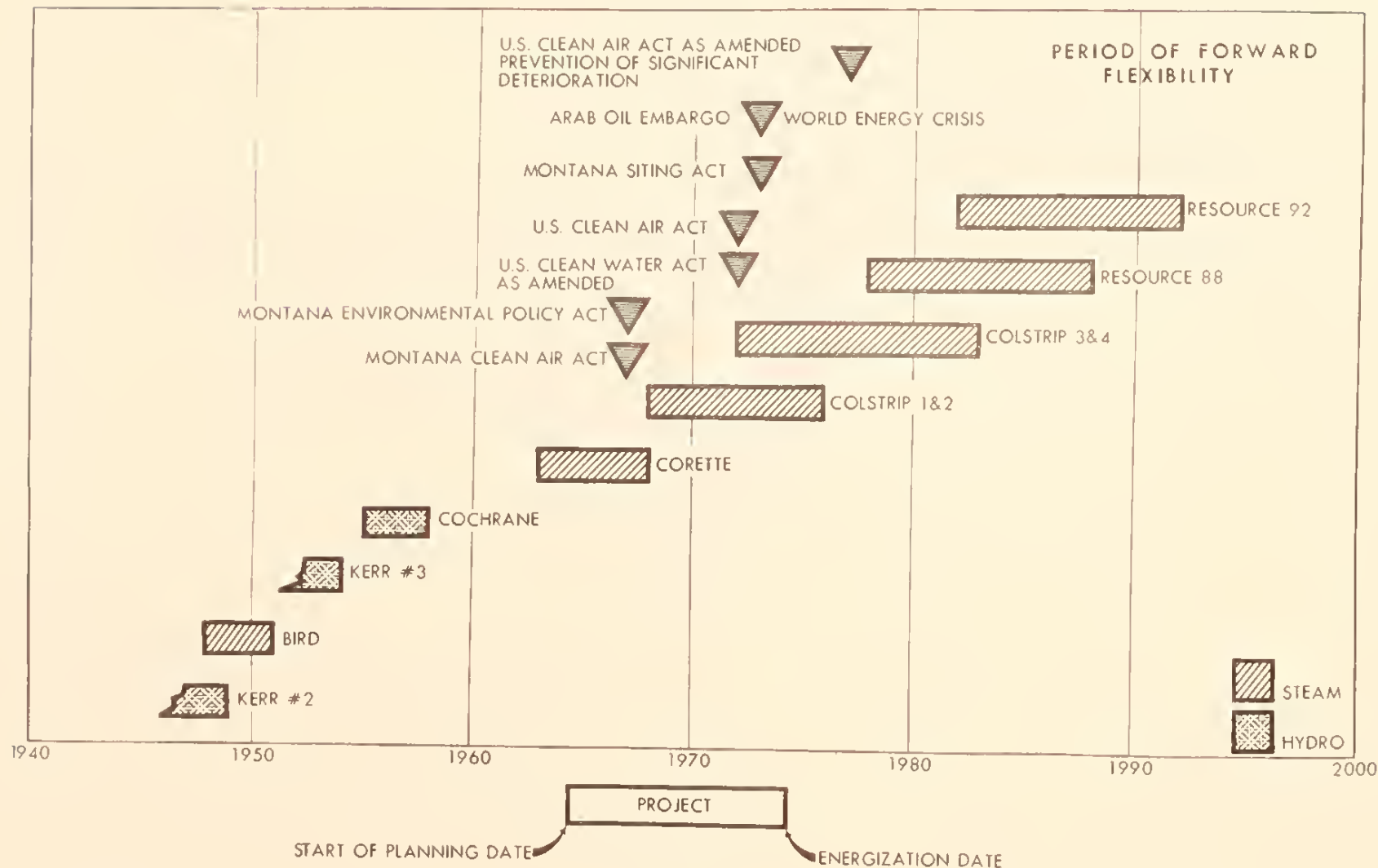
COLSTRIP 3&4 DELAYED 2 YEARS  
1984-85



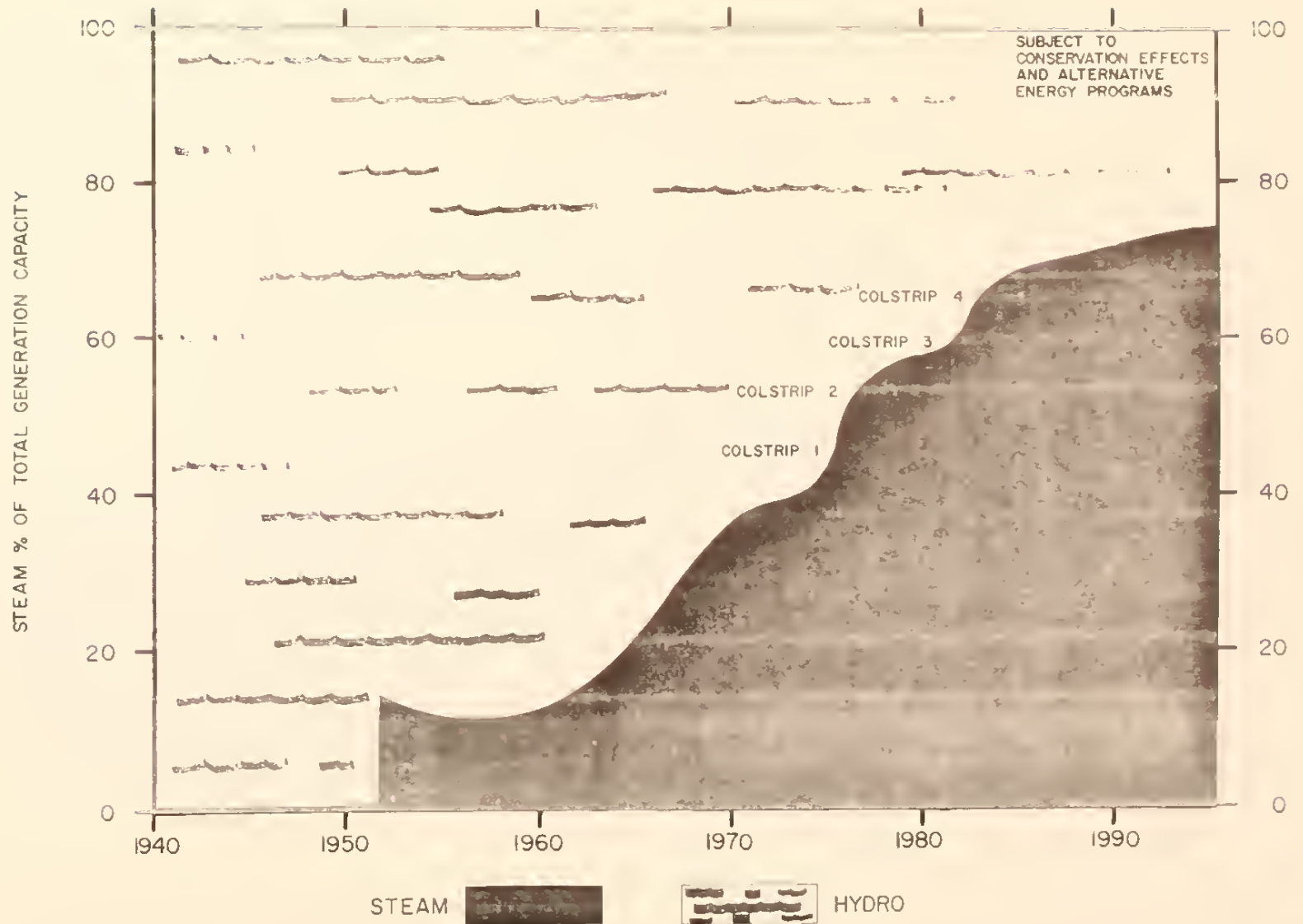
## NEW DIRECTIONS IN ENERGY

- . HOW WE GOT WHERE WE ARE
  - . Hydro Was Best Available Resource in Early Years
    - . New hydro was not available in the late 1960's
  - . Montana Coal Next Best Alternative
    - . Today's mix of hydro, thermal & purchases is optimum

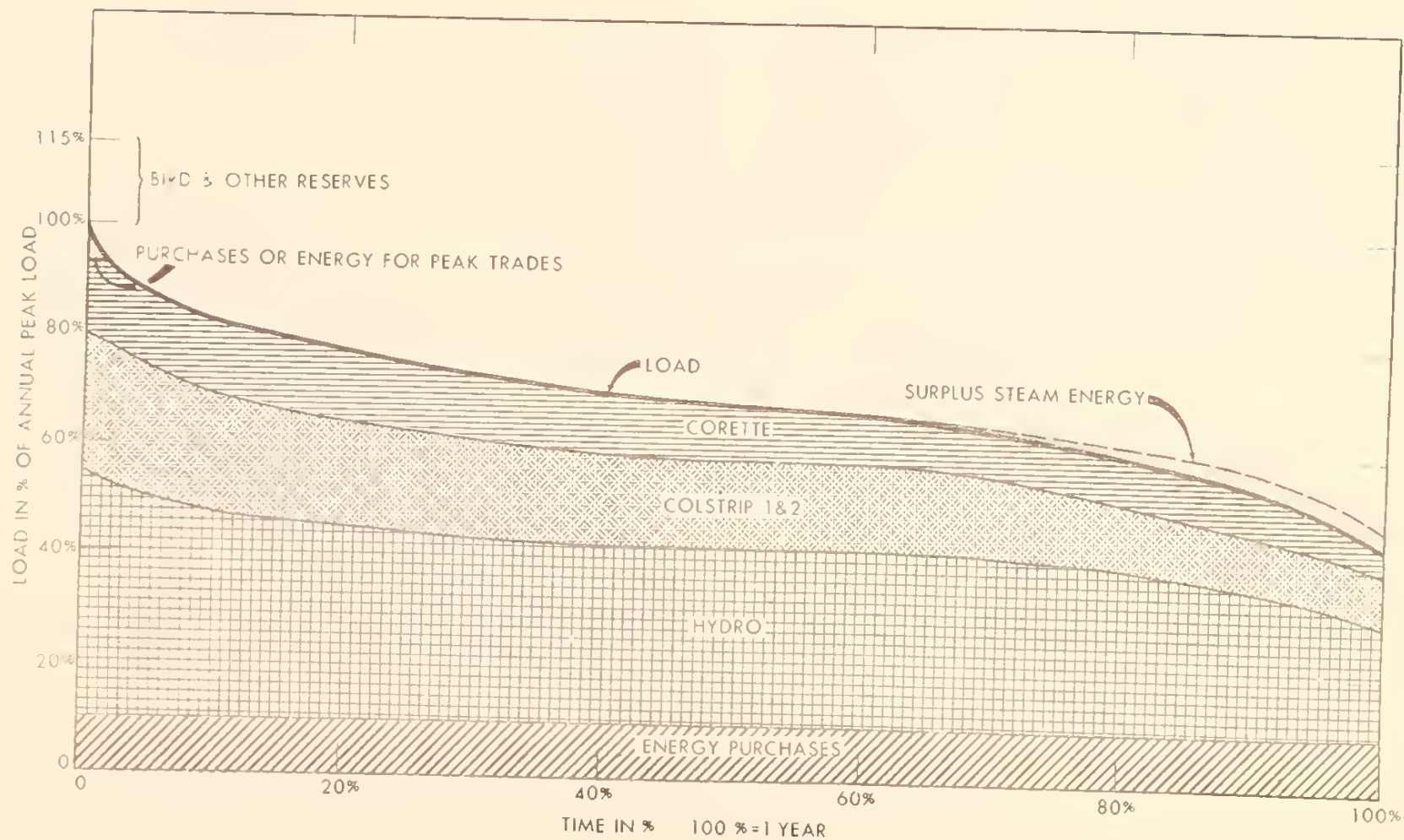
# MAJOR EVENTS AFFECTING ELECTRICAL ENERGY RESOURCE PLANNING



# MAIN LINE OPTION FUTURE GENERATION MIX



# RESOURCES MIX SHAPED TO LOAD DURATION CURVE



## NEW DIRECTIONS IN ENERGY

- . HOW WE GOT WHERE WE ARE -2
  - . 1968-1975. Colstrip #1 and #2
    - . Planning Factors
      - . The Colstrip #1 and #2 Review
        - . Hydro sites not available
        - . Nuclear couldn't compete with coal in Montana System
        - . Siting studies
        - . Economic/Environmental Optimization Studies

## NEW DIRECTIONS IN ENERGY

### . PLANNING FACTORS - 2

#### . More Detailed Components of Basic Factors

##### . Applied to All Studies

##### . Technology/Fuel Source

. Conventional...oil, gas, coal, nuclear, hydro

. Developing alternative sources: e.g. wind, solar, geothermal

##### . 40 year "least cost alternative studies"

. plant size

. water supply

. location

. interest rates

. environmental impact

. inflation

. timing

. power purchases

. freight rates

. power sales

. transmission

. partnership/economics

. system reserve

. e.g. Puget

. economy of scale

. e.g. Four Partners

. technology/fuel source

. others

. lead times

## NEW DIRECTIONS IN ENERGY

### . PLANNING FACTORS - 3

#### . Example 1 - Colstrip #1 and #2

- . Three sites "broke even" economically
- . Best site had least environmental impact, best supply of water: Colstrip

#### . Example 2 - Colstrip #3 and #4

- . Colstrip still (1972) "best site" as above
  - . Environmentally Compatible
  - . Economical
  - . Reliable
- . Economic trade off factors-partnership: \$4 million per year savings

# 1970 STEAM PLANT SITING STUDY FOR 3 COAL FIRED 330 NET MW \*1 TO BE INSTALLED IN 1974

| GENERATION PLUS ADDED<br>TRANSMISSION ANNUAL<br>LEVELIZED COST | CUSHMAN<br>50 MI. NW BILLINGS<br>\$ 31,109,000 | SPRINGDALE<br>NEAR LIVINGSTON<br>\$ 31,382,000 | COLSTRIP<br>\$ 30,419,000 |
|----------------------------------------------------------------|------------------------------------------------|------------------------------------------------|---------------------------|
|----------------------------------------------------------------|------------------------------------------------|------------------------------------------------|---------------------------|

**COSTS ARE NEARLY EQUAL  
COMPARISON IS NOT DECISIVE**

• **OTHER DECISION FACTORS:**

• **FUEL SUPPLY RELIABILITY**

COLSTRIP IS MINE MOUTH, OTHERS REQUIRE RAILROAD HAULAGE

• **WATER SUPPLY**

COLSTRIP DRAWS FROM YELLOWSTONE, OTHERS FROM TRIBUTARIES

• **ENVIRONMENTAL**

COLSTRIP IS ENVIRONMENTALLY COMPATIBLE

THIS IS A SIMPLIFIED EXAMPLE OF BUT ONE OF MANY STUDIES  
INVESTIGATING ECONOMIC, ENVIRONMENTAL, AND OTHER  
ASPECTS OF GENERATING PLANT PLANNING.

# 1973 STUDY COMPARING MONTANA POWER OWNERSHIP OF 2-350 MW UNITS VS JOINT OWNERSHIP OF 2-700 MW UNITS AT COLSTRIP

FIGURES ARE LEVELIZED ANNUAL COSTS  
IN 1975 DOLLARS  
IN THOUSANDS

|                         | 2-MONTANA POWER<br>OWNED 350 MW<br>UNITS | 2-JOINTLY OWNED<br>700 MW UNITS<br>MONTANA POWER SHARE 30% |
|-------------------------|------------------------------------------|------------------------------------------------------------|
| GENERATION              | \$ 40,018                                | \$ 35,282                                                  |
| TRANSMISSION            | \$ 4,975                                 | \$ 5,968                                                   |
| NET PURCHASES *(SALES). |                                          |                                                            |
| PEAK AND ENERGY         | \$ 2,511                                 | \$ 3,208                                                   |
| TOTALS                  | \$ 42,482                                | \$ 38,042                                                  |

SAVINGS TO MONTANA POWER AND IT'S CONSUMERS FOR JOINT  
OWNERSHIP IS \$4,440,000 ANNUALLY

# 1973 STUDY COMPARING MONTANA POWER OWNERSHIP OF 2-350 MW UNITS VS JOINT OWNERSHIP OF 2-700 MW UNITS AT COLSTRIP

FIGURES ARE LEVELIZED ANNUAL COSTS  
IN 1975 DOLLARS  
IN THOUSANDS

## PARAMETER SENSITIVITY STUDY

|                                                   | 2- MONTANA POWER<br>OWNED 350 MW<br>UNITS | 2- JOINTLY OWNED<br>700 MW UNITS<br>MONTANA POWER<br>SHARE 30 % |
|---------------------------------------------------|-------------------------------------------|-----------------------------------------------------------------|
| ESCALATION- SIMPLE INTEREST                       |                                           |                                                                 |
| 3%                                                | \$ 40,194                                 | 36,152                                                          |
| 5%                                                | 42,482                                    | 38,042                                                          |
| 7%                                                | 44,770                                    | 39,962                                                          |
| SURPLUS SALES                                     |                                           |                                                                 |
| NO SALES                                          | 44,993                                    | 41,250                                                          |
| 50% SALES                                         | 42,482                                    | 38,042                                                          |
| MONTANA POWER<br>% PARTICIPATION<br>IN JOINT UNIT |                                           |                                                                 |
| 25                                                |                                           | 38,023                                                          |
| 30                                                |                                           | 38,042                                                          |
| 35                                                |                                           | 38,106                                                          |
| 100                                               |                                           | 42,482                                                          |

## NEW DIRECTIONS IN ENERGY

### . DEVELOPING ALTERNATIVES FOR THE FUTURE - 1

#### . Sources of Supply

#### . Importance of Colstrip #3 and #4 as energy source

- . Basic strategy: Develop a way in which it can be completed, acceptable to all concerned

#### . Some additional "ingredients" for alternative plans

#### . Hydro

- . Buffalo Rapids (again)

- . Small hydro

- . Expansion of existing hydro

- . Limits of hydro

#### . Purchased power (but sources in 1980's and beyond uncertain)

- . Industrial co-generation

- . Effects of conservation

- . Potential gains from

- . Solar

- . Wind

- . Aim is to push need for new generation source out as far as possible to minimize cost to consumers

## NEW DIRECTIONS IN ENERGY

- . DEVELOPING ALTERNATIVES FOR THE FUTURE - 2
  - . Role of Conservation and Alternative Energy Programs for the Future
    - . Flexibility in planning
    - . Strong conservation ethic and program needed  
(National Academy of Science Study)
    - . Alternative energy programs aimed at:
      - . Reduced cost in future
      - . Enhanced environment
      - . Conservation of fossil fuels
      - . Reduced dependence on foreign oil
    - . Technological development needed
      - . MPC's involvement
        - . Wind
        - . Solar
        - . MHD
  - . Timing: development -- testing -- production
    - . Late '70's - 80's - 90's and beyond
    - . A very small factor now -- increasing through time
  - . Key Test: Practical, environmentally compatible, economically beneficial to consumers

## NEW DIRECTIONS IN ENERGY

- . OUTLOOK FOR THE FUTURE
  - . One "Optimum" Plan
    - . Effects of conservation/alternative energy sources
      - . Early 80's
      - . Late 80's - effect on "Resource '88"
  - . Colstrip #3 and #4
  - . Resource 1988
  - . Flexibility and Prudent Planning
    - . Considering the alternatives
    - . Continuing projections of future energy needs
      - . Tracking, evaluating, reporting results --- new projections
      - . "If.....then" principle of projections
      - . "If this happens,.....then that is also likely to happen"
        - . Based on current facts, reasonable assumptions for future
    - . We expect change
    - . Building a road map to the future

## NEW DIRECTIONS IN ENERGY

- . Basic Costs for "Most Likely Alternatives"
  - . Capital costs for implementation
    - . Colstrip #3 and #4
    - . Provision for "purchased power" to cover short delay in Colstrip #3 and #4
      - . No certainty that power can be purchased in early '80s and beyond
  - . "Resource 1988"
  - . Matching transmission
- . Looking to the future with confidence
  - . The challenge ahead
  - . The balanced approach

# MAIN LINE OPTION FUTURE ELECTRIC SUPPLY PLAN

## COSTS IN MILLIONS OF DOLLARS

|                                                            | 1978              | 1979             | 1980               | 1981                | 1982              | 1983      | 1984         | 1985               | 1986                 | 1987              | 1988               | 1989  | 1990  |
|------------------------------------------------------------|-------------------|------------------|--------------------|---------------------|-------------------|-----------|--------------|--------------------|----------------------|-------------------|--------------------|-------|-------|
| * COLSTRIP*3 & 4<br>GENERATION<br>TRANSMISSION<br>SUBTOTAL | 154<br>.7<br>16.1 | 539<br>93<br>632 | 670<br>201<br>87.1 | 730<br>439<br>116.9 | 631<br>4.9<br>620 | 510       |              |                    |                      |                   |                    |       |       |
| 1987 PEAKING TURBINE UNITS                                 |                   |                  |                    |                     |                   |           |              |                    | 7.0                  | 30.0              |                    |       |       |
| 1988 STEAM UNIT<br>GENERATION<br>TRANSMISSION<br>SUBTOTAL  |                   | .3<br>3          | 1.0<br>10          | 5.7<br>.8<br>6.5    | 3.7<br>37         | 3.7<br>37 | 21.2<br>21.2 | 66.3<br>.8<br>67.1 | 131.5<br>39<br>135.4 | 433<br>8.1<br>514 | 135<br>4.2<br>17.7 |       |       |
| 1992 STEAM PLANT                                           |                   |                  |                    |                     |                   | .4        | 1.4          | 7.7                | 5.0                  | 5.1               | 28.8               | 90.2  | 178.9 |
| THERMAL PLANT IMPROVEMENT                                  | 9.4               | 2.5              | 6.7                | 19.8                | 23.7              | 11.3      | 6.9          | 11.0               | 8.2                  | 15.5              | 8.5                | 9.1   | 9.7   |
| HYDRO PLANT IMPROVEMENT                                    | 1.3               | 2.4              | 1.3                | .9                  | 11.7              | 9.9       | 2.1          | 6.6                | 6.5                  | 1.0               | .5                 | .5    | .5    |
| TRANSMISSION                                               | 3.3               | 4.2              | 9.7                | 21.3                | 11.2              | 3.8       | 3.0          | 3.2                | 3.5                  | 3.8               | 4.1                | 4.4   | 4.8   |
| DISTRIBUTION                                               | 11.3              | 7.7              | 8.1                | 8.6                 | 9.1               | 9.7       | 10.2         | 10.9               | 11.5                 | 12.2              | 12.9               | 13.7  | 14.5  |
| GENERAL (COMMUNICATIONS, OTHER)                            | 1.0               | 1.5              | 1.2                | 1.3                 | 1.4               | 1.5       | 1.6          | 1.7                | 1.8                  | 1.9               | 2.1                | 2.2   | 2.4   |
| TOTAL YEARLY EXPENDITURE                                   | 42.4              | 81.8             | 115.1              | 175.3               | 128.8             | 91.3      | 46.4         | 108.2              | 178.7                | 120.9             | 74.6               | 120.1 | 210.8 |

\* MONTANA POWER'S PARTICIPATION COST ONLY (30%)

# ACCUMULATED PLANT EXPENDITURES TO 1990 BY CATEGORY IN MILLIONS OF DOLLARS

|                           | <u>UP TO 1977</u> | <u>1978-1990</u> | <u>TOTAL</u> |
|---------------------------|-------------------|------------------|--------------|
| COLSTRIP UNITS 3 & 4 *    |                   |                  |              |
| GENERATION                | 17.4              | 323.4            | 340.8        |
| TRANSMISSION              | <u>5.5</u>        | <u>79.0</u>      | <u>84.5</u>  |
| TOTAL                     | 22.9              | 402.4            | 425.3        |
| 1978 PEAKING TURBINE      | —                 | 37.0             | 37.0         |
| 1988 STEAM UNIT           |                   |                  |              |
| GENERATION                | —                 | 290.2            | 290.2        |
| TRANSMISSION              | —                 | <u>17.8</u>      | <u>17.8</u>  |
| TOTAL                     | —                 | 308.0            | 308.0        |
| 1992 STEAM UNIT           | —                 | 317.5            | 317.5        |
| THERMAL PLANT IMPROVEMENT | —                 | 142.2            | 142.2        |
| HYDRO PLANT IMPROVEMENT   | —                 | 45.2             | 45.2         |
| TRANSMISSION              | —                 | 80.2             | 80.2         |
| DISTRIBUTION              | —                 | 140.3            | 140.3        |
| GENERAL                   | —                 | 21.3             | 21.3         |
| EXISTING PLANT            | <u>536.8</u>      | <u>—</u>         | <u>536.8</u> |
| TOTAL                     | 559.8             | 1494.1           | 2053.8       |

\* MONTANA POWER PARTICIPATION SHARE (30%)



A VIEW OF MONTANA'S ELECTRICAL ENERGY PICTURE

- . IMPORTANCE OF RELIABLE SUPPLY OF ENERGY
- . COSTS OF SUPPLY
- . WHAT IT TAKES TO INSURE THE SUPPLY
- . WHAT THIS MEANS TO THE CONSUMER: COSTS OF DELIVERED ENERGY

## DIRECTIONS IN ENERGY

- . WHAT IT TAKES TO INSURE A RELIABLE SUPPLY OF ENERGY IN MONTANA
  - . We Have Been Discussing:
    - . Electrical demand history and outlook in Montana
    - . The U. S. and Montana Energy outlook -- and the outlook for conservation and alternative energy resources
    - . The basic alternatives we in Montana have on which to base our energy plan
      - . dealing with the demand/supply equation
    - . The importance of certainty of supply to our economy, environment and quality of life
      - . our common objectives
  - . Now We Turn To a Discussion of "What It Takes" to Insure That Reliable Supply
  - . Projections of Capital Requirements and Expenditures
    - . Uncertainty of long-range forecasts
    - . Projections based on series of facts known today ... and reasonable assumptions for the future
    - . "If this happens ... then that is likely to happen"
    - . Expect projections to change ... but great value for future planning, tracking and evaluating implications for future

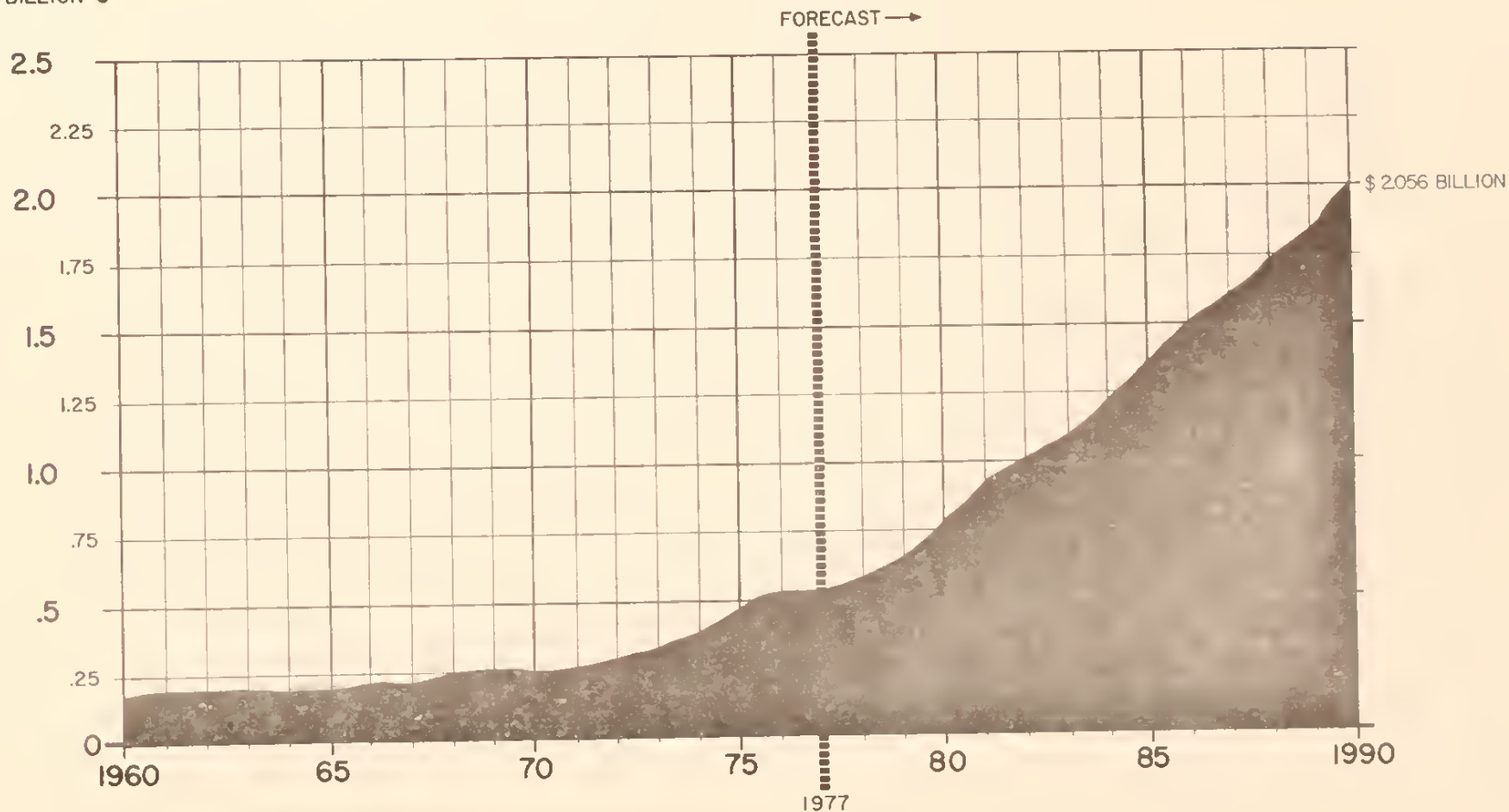
## NEW DIRECTIONS IN ENERGY

- . WHAT IT TAKES TO INSURE A RELIABLE SUPPLY OF ENERGY IN MONTANA -2
  - . Step 1: Basic Capital Requirements Tied to One "Optimum" Electrical Energy Management Plan
  - . Step 2: A Summary of Cumulative Electrical Plant Expenditures on a "What We Have Now" Plus "Pay As You Go" basis
    - . This totals our planned expenditure to insure the reliable supply, in accordance with the baseline plan

# ELECTRIC UTILITY PLANT

IN SERVICE AND ANNUAL CONSTRUCTION EXPENDITURES

BILLION \$



## NEW DIRECTIONS IN ENERGY

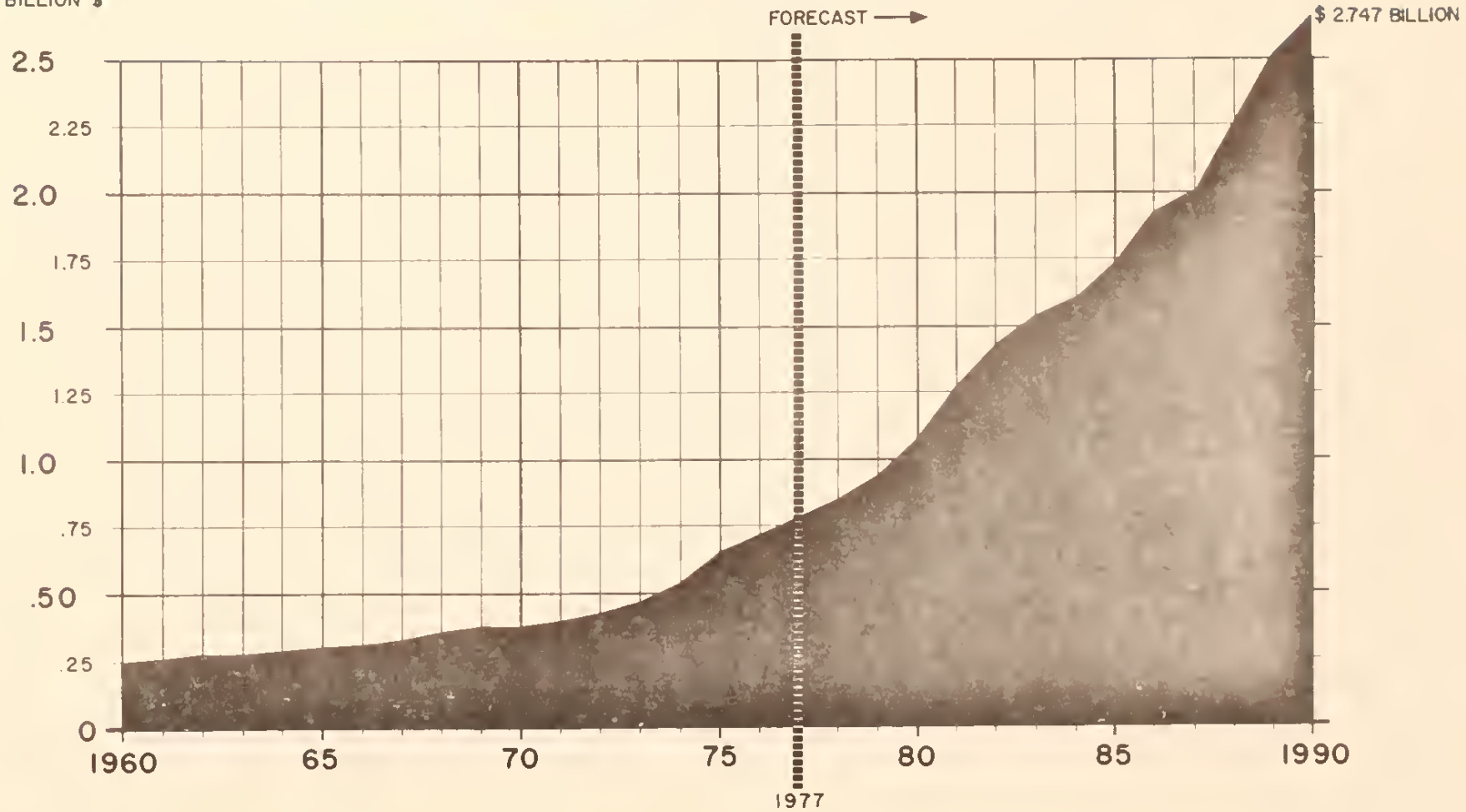
### . WHAT IT TAKES TO INSURE A RELIABLE SUPPLY OF ENERGY IN MONTANA -3

- . Step 3: Calculating Total Utility Plant, Including Gas, Electric, Water and "Common"
  - . Purpose: Define the total utility financial task
    - . directly related to gas, electric demand and reliable supply
  - . Observation: The dollar values become large, but very "normal" in a service area as large as Western Montana
  - . Result: A basis for determining financial plan to support the common goal

# UTILITY PLANT

## IN SERVICE AND ANNUAL CONSTRUCTION EXPENDITURES

BILLION \$

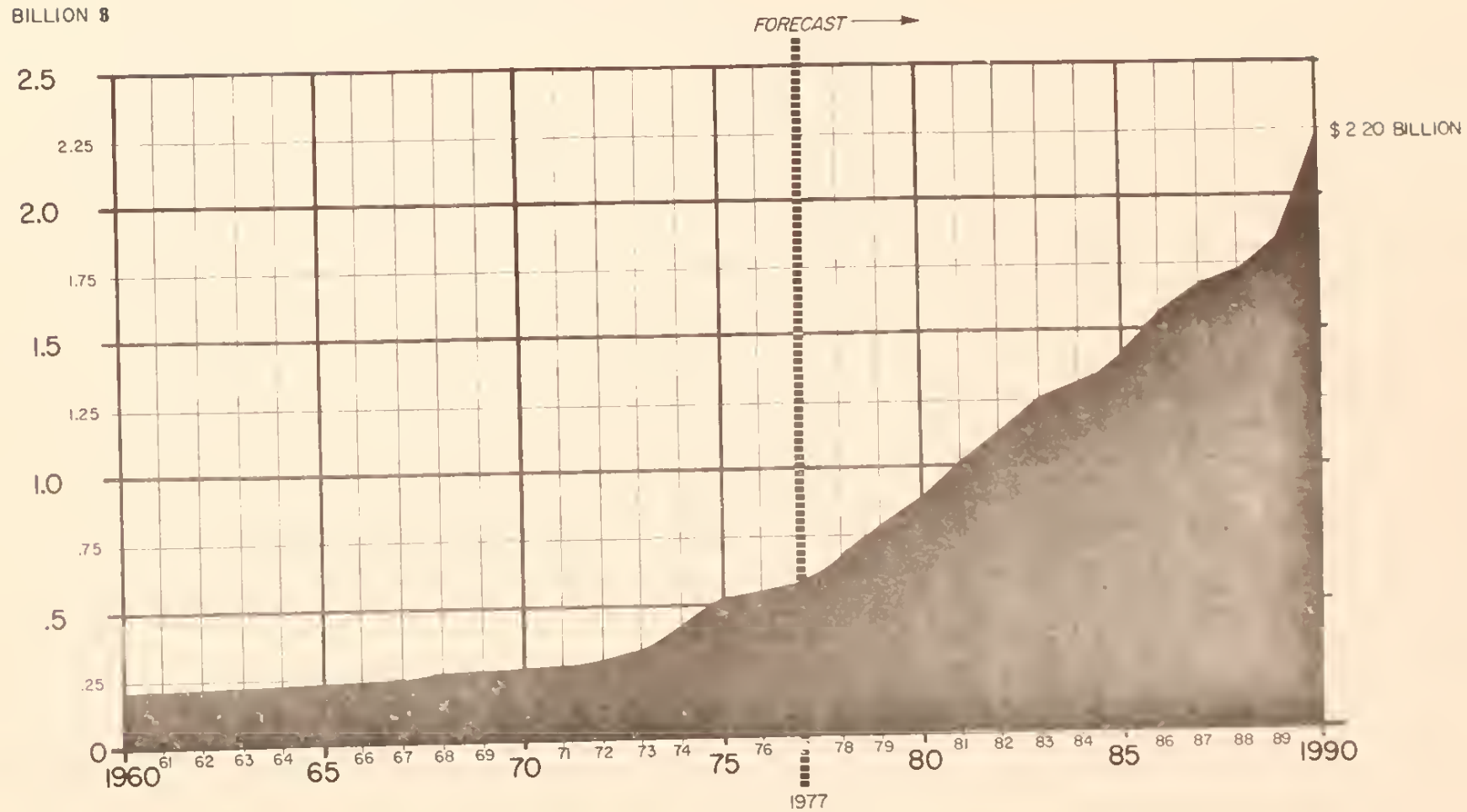


NEW DIRECTIONS IN ENERGY

- . WHAT IT TAKES TO INSURE A RELIABLE SUPPLY OF ENERGY IN MONTANA -4
- . Step 4: Calculating Total Plant Less Depreciation
- . Purpose: Establishes value of rate base

# DEPRECIATED UTILITY PLANT

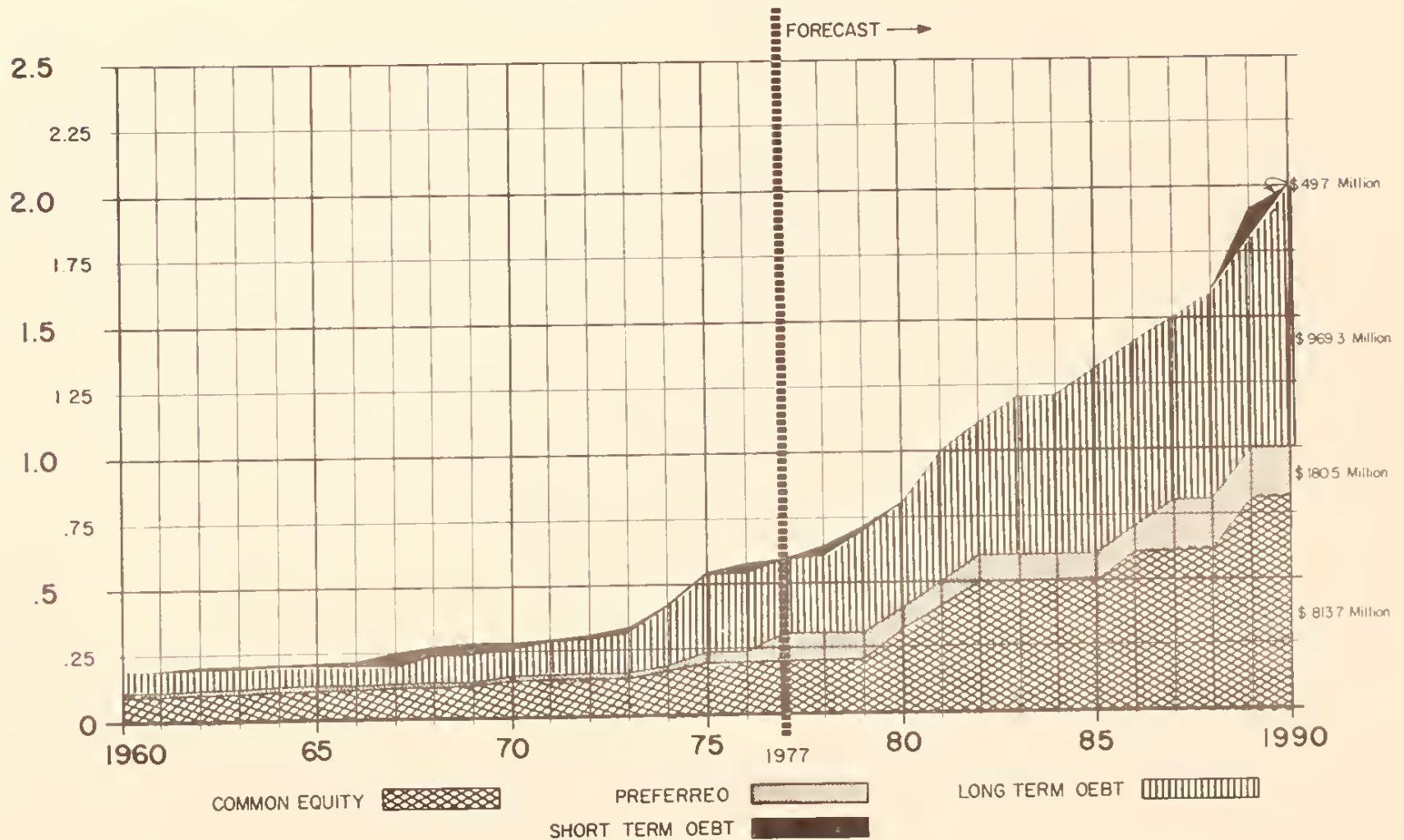
## IN SERVICE AND ANNUAL CONSTRUCTION EXPENDITURES



## NEW DIRECTIONS IN ENERGY

- . WHAT IT TAKES TO INSURE A RELIABLE SUPPLY OF ENERGY IN MONTANA -5
- . Step 5: The Capital Structure Projection or the Plan Whereby We Provide the Financial Resources to Insure the Reliable Supply of Energy
  - . Total utility expenditures to support the plan that provides the gas and electrical resources
  - . Sources of funds -- and the plan to acquire them
    - . current income
    - . common stock offerings
    - . preferred stock
    - . debt
      - . long term
      - . short term
    - . other
  - . Magnitude of the task
  - . Importance of sound financial condition to assure reliable energy supply. The common goal
  - . Next, "What this means to the residential consumer"

# UTILITY CAPITALIZATION AND SHORT TERM BORROWING



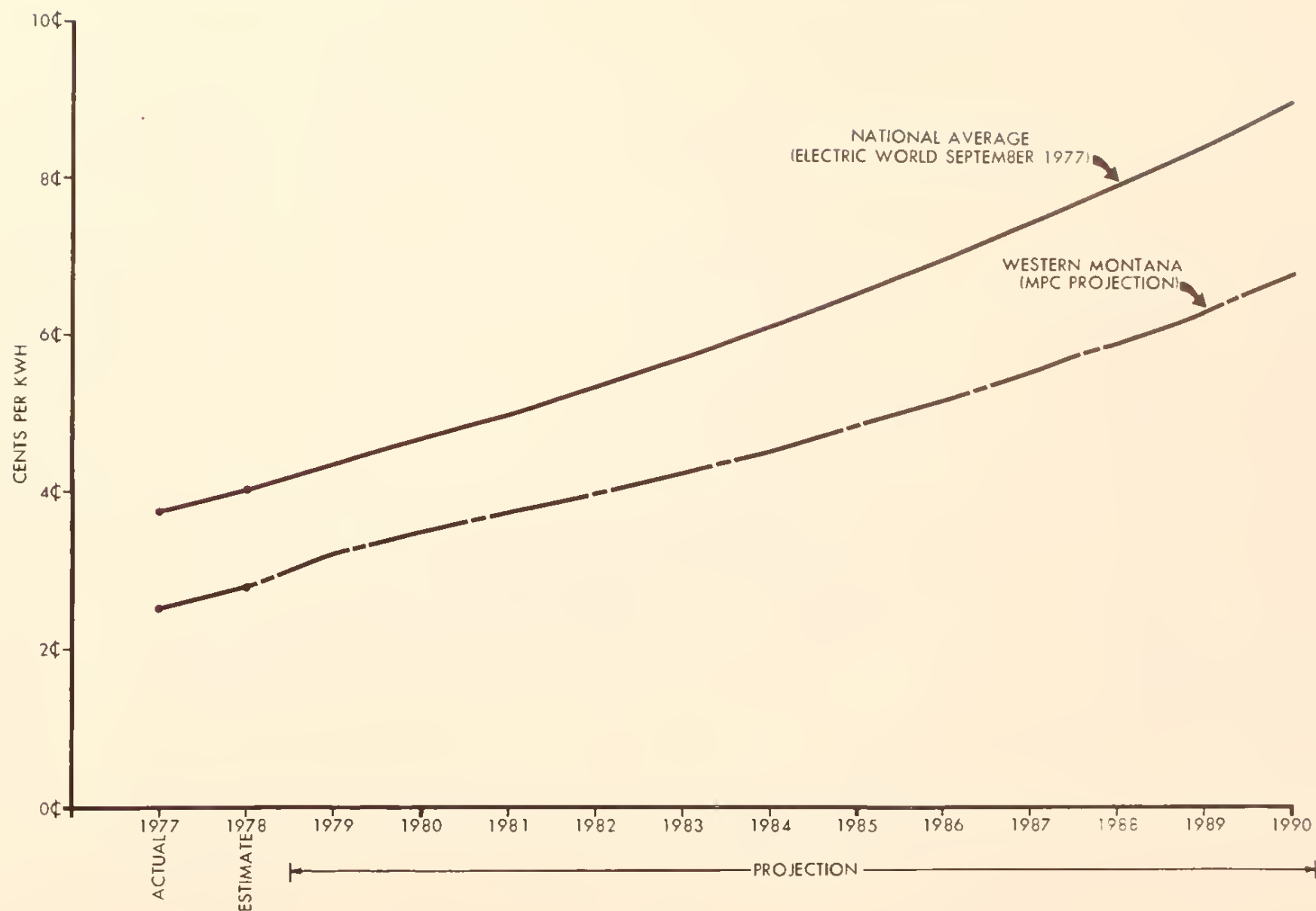
## NEW DIRECTIONS IN ENERGY

### . WHAT THIS ALL MEANS TO THE RESIDENTIAL CONSUMER

#### . Western Montana Compared to United States Averages

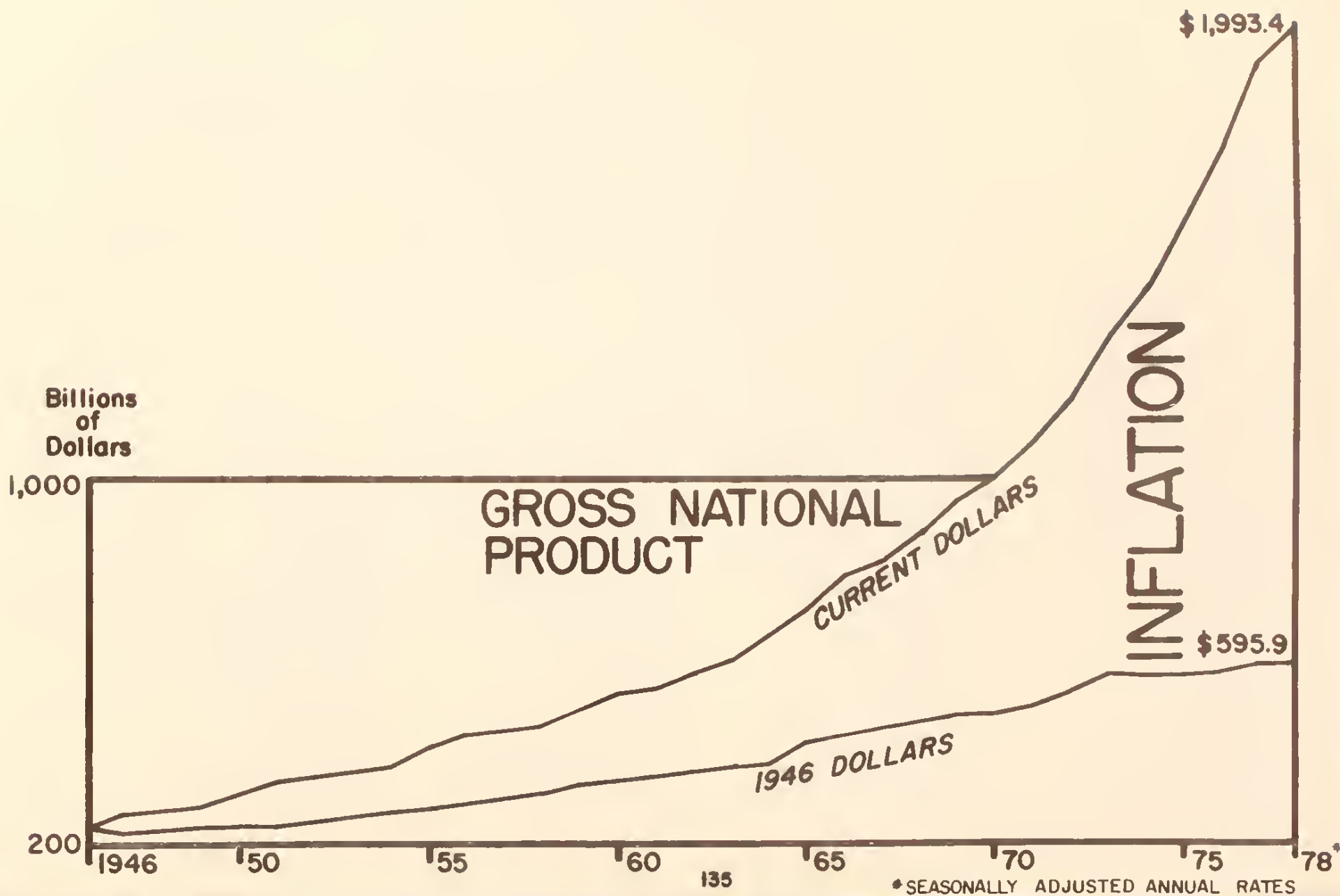
- . Following the program envisioned here, we in Montana can achieve the basic objective
  - . safe, reliable supply of energy at a reasonable cost, at a reasonable profit, as compatibly with the environment as possible
- . Based On Current Projections, There Would Be a Planned Gradual, Logical, Increase in the Cost of Energy, Proportional to World/National Costs of Energy and Related Living Costs
- . Montana Consumer Costs per kWh Remain Well Below National Average, as Published by McGraw-Hill, Electrical World, September 15, 1977

# COST OF ELECTRICAL ENERGY TO THE RESIDENTIAL CONSUMER (CURRENT DOLLARS)





Source: Newsweek Magazine  
5/29/78



## NEW DIRECTIONS IN ENERGY

### . WHAT THIS ALL MEANS TO THE RESIDENTIAL CONSUMER -2

#### . Western Montana Compared to the United States

- . Major difficulty or enemy is inflation. Chart shows that without inflation "true" energy cost increases are very small, following the program.
- . Through 1990, our projections show Western Montana well below national averages in terms of energy costs to residential consumers
- . benefit of sound energy management program in which each of us and every consumer plays an important role
  - . prudent planning and action
  - . strong conservation efforts
  - . capitalizing on best alternative
  - . sufficient revenues to insure reliable supply in the future
  - . innovative approach to the challenge ahead
- . The importance of insuring a reliable supply of energy
- . Balance energy, economy, environment and the quality of life

# COST OF ELECTRICAL ENERGY TO THE RESIDENTIAL CUSTOMER (CURRENT AND CONSTANT 1978 DOLLARS)

